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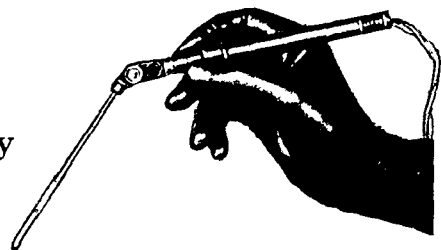


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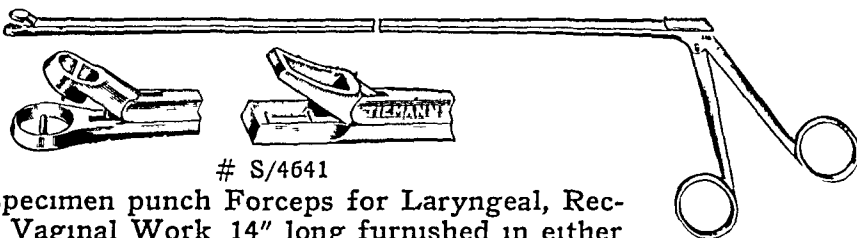
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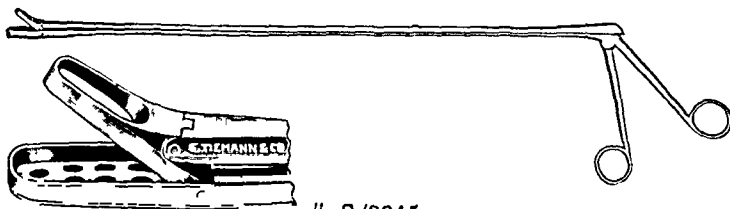
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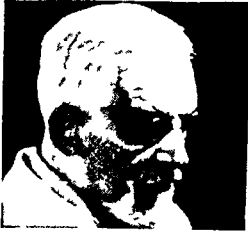
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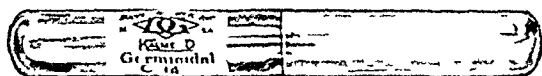
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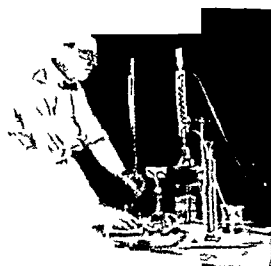


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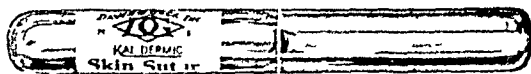


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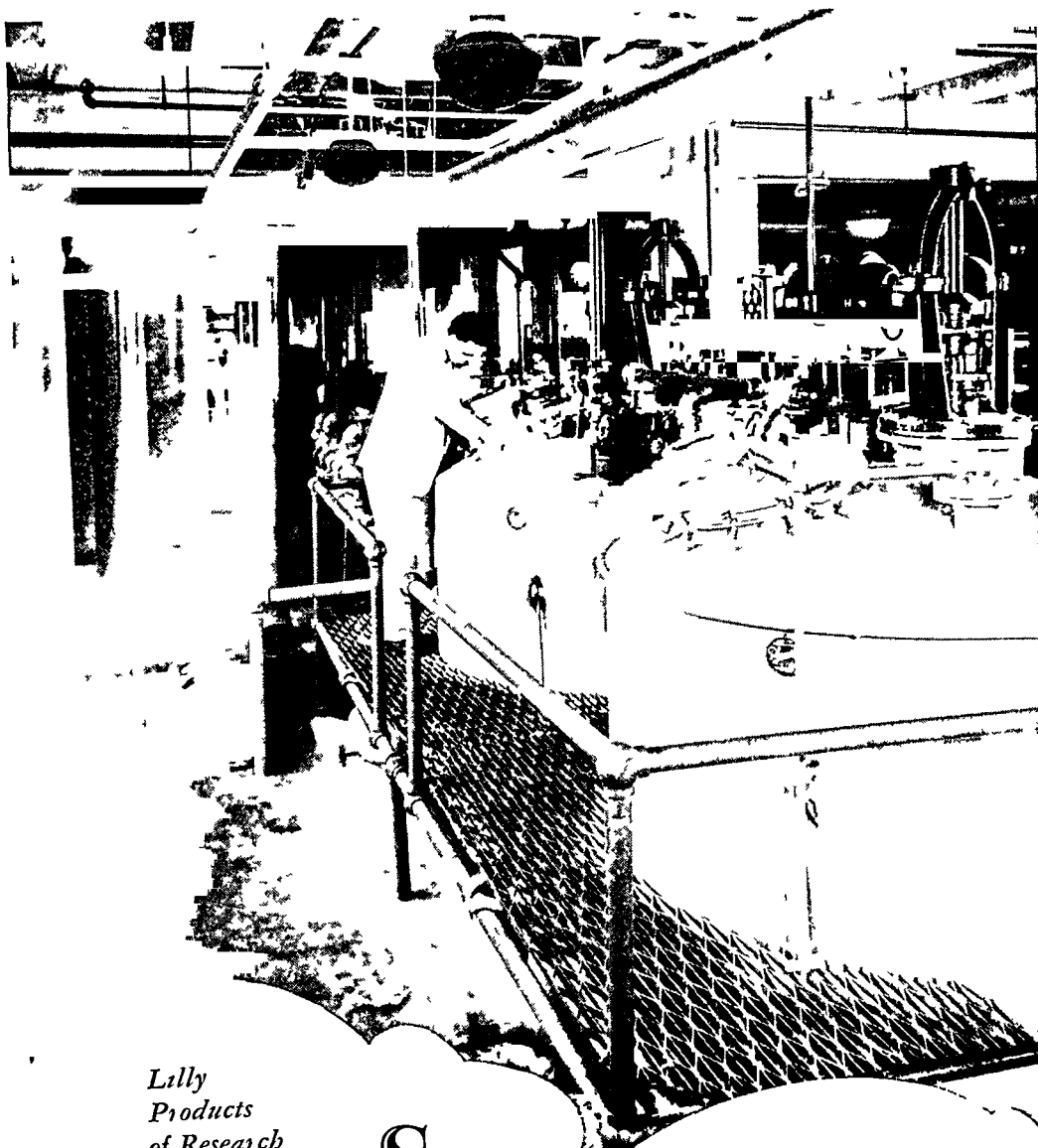
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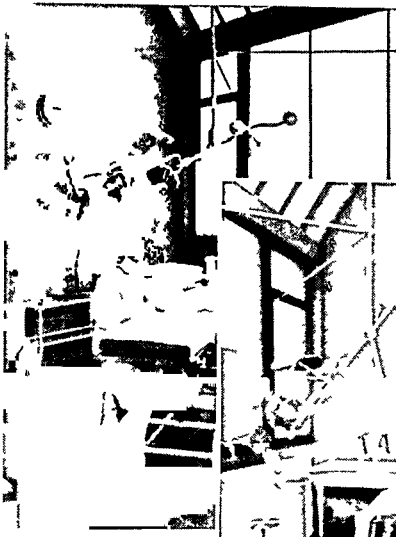
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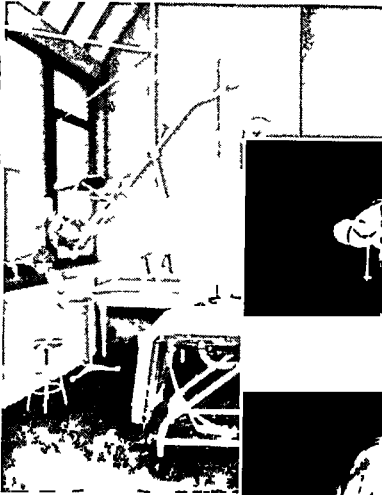
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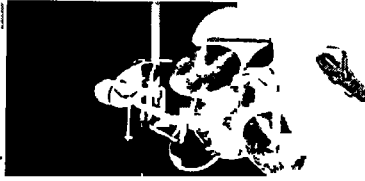
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bone posteriorly. A blood transfusion was given the day before operation, which was done in June, 1925. At operation the tumor was exposed by reflecting the soft tissues from it, rongeur-ing away a thin shell of bone at the angle of the jaw, and peeling the tumor out of its bony bed. This was readily done as there was a very definite



FIG 3—Case I Showing local recurrences after conservative removal



FIG 4—Case I Showing end result after radical resection of jaw

cleavage plane. The tumor was slightly torn at one point. The patient was fed with a nasal tube for two weeks. The convalescence was complicated by an osteomyelitis of the jaw which readily cleared up following the extrusion of a sequestrum. The patient remained well until January, 1927, eighteen months after the first operation.



FIG 5—Case II



FIG 6—Case II Note the infected sloughing areas

At that time she returned to the hospital with several large and small recurrences in the bone and in the soft tissues. A second operation was done and the jaw resected from angle to angle. She has remained well (Figs 3 and 4).

*Pathology*—The tumor was found to contain many cyst-like areas of varying size, some being as large as 7 centimetres in diameter. These cysts as a rule contained

artery on the right side was done with a piece of tape. The wound was left open until the completion of the operation when the constricting band was removed and the wound closed. At operation the soft tissues were reflected off the tumor, the ulcerated skin areas being left attached to the tumor mass. The jaw was sawed through to the left of the middle line, and the tumor-bearing area swung out and the jaw disarticulated at the temporo-mandibular joint. There was practically no arterial bleeding owing to the ligation of the common carotid, but there were huge veins which entered the tumor from the region of the antrum and the temporal fossa. The wound was closed without drainage. A second transfusion was given while the patient was on the operating table at the close of the operation. Following the operation the patient was fed with a nasal tube for several weeks until she could swallow and chew her food satisfactorily. An uneventful recovery ensued. The patient has remained well to date (Fig 7).

*Pathology*—On section the tumor was found to consist of many cysts filled with gelatinous material. The bone was practically entirely destroyed. There were many areas of solid cellular tumor interposed among the cysts. There were many hard, bony-

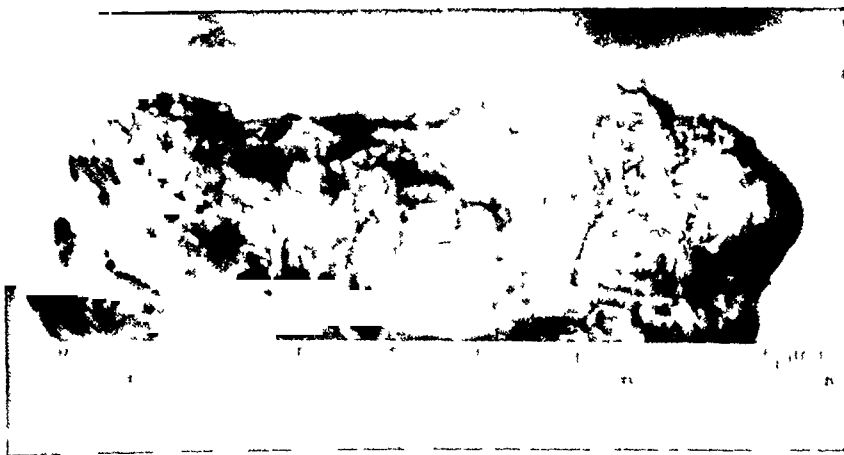


FIG 6—The tumor in Case II

like areas in the tumor. The microscopic sections showed an example of all of the types of cells described in adamantinoma (Figs 8 and 9).

CASE III—J W, female, aged thirty-one, M-7906. Admitted to the Cincinnati General Hospital, August 1927. Twelve years before admission a lump was noticed in the right lower jaw following the removal of a tooth. The tumor grew steadily and slowly until two years before admission when it began to grow larger rapidly, and to cause a great deal of pain. Six months before admission the tumor mass was incised by the family physician. Some thin, bloody fluid escaped. From then on until her admission to the Cincinnati General Hospital a few months later she lost considerable weight and strength owing to her inability to masticate her food. When admitted to the hospital her temperature was 99°, pulse 100, white blood cells 8,000, red blood cells, 4,000,000, hemoglobin 90 per cent. The patient's general condition was good. She presented a tumor mass occupying the mandible from the temporal mandibular joint to the point of the chin. This mass extended well into the mouth where it had separated the teeth widely and had thinned the bone out to a very thin sheet over most of the tumor on its lateral aspect. Ping-pong ball crepitus could be made out over most of the tumor. There were a few soft, cystic areas. Operation was done August 30, 1927. A ligation of the external carotid artery was done as a preliminary. The jaw was sawed through with a Gigli saw just medial to the left second incisor. The tumor mass and jaw were swung laterally and disarticulation of the temporo-

in the upper jaw, which are more often solid, and consequently are more malignant and of more serious prognosis. The tumors are found within the alveolar borders of the jaw and expand the bone to parchment-like thinness as they enlarge, giving rise to the ping-pong ball crepitus so often elicited. The tumor may break through the bone and extend into neighboring structures.

Adamantinoma occur chiefly in adults and many are found in patients from sixty to seventy years of age. Our tumors were all in women, which is in accord with the fact that they are more often affected than men. It is of interest to note that in each case there was a history of the tumor beginning after the extraction of a tooth. Trauma or infection, and continued irritation, are supposed to produce the stimulus to the paradental epithelial debris necessary to start the growth, and thus produce the tumor. The tumors grow slowly. Two of our cases showed a duration of twelve years and one of eleven. There was no metastasis in our series. This type of tumor rarely metastasizes. Ewing<sup>3</sup> has seen metastasis twice to the cervical glands. Of Simmons<sup>2</sup> twelve cases two showed late metastasis to the cervical glands.

All three of our cases had had one or more conservative operations followed by local recurrences, and with each recurrence the tumor reappeared more promptly and grew more rapidly. Simmons<sup>2</sup> found that in ten of his twelve cases recurrences followed local removal. We have practised and advised radical resection of the jaw. All of our cases have remained well following such a procedure. New<sup>4</sup> reports one case treated by surgical diathermy with local recurrence in three months but on second destruction by diathermy the tumor has not reappeared for two years. Preliminary ligation of the external carotid in one case and temporary occlusion of the common carotid in another considerably facilitated the removal of two of the huge tumors in my series. Feeding with a nasal tube during convalescence was practiced in all three cases and transfusions were used twice in the debilitated and anæmic patients.

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- <sup>1</sup> Murphy, J. T. Radiology, vol. III, p. 377-382, 1924.
- <sup>2</sup> Simmons, C. C. ANNALS OF SURGERY, vol. LXXXVIII, p. 693, October, 1928.
- <sup>3</sup> Ewing, James. Neoplastic Diseases, p. 709, 1922.
- <sup>4</sup> New, G. B. Surg. Clin. of North America, vol. IX, p. 80, February, 1929.

found in our series. It is of interest to note that only two of the mild cases had a history of diabetes, and one of these syphilis. No other chronic ailments were present. Two of the fatal cases had an incision and drainage done, with very little pus found. No ligations of the facial veins were done. I desire to emphasize the fact that in the Lebanon Hospital series no case of primary *staphylococcus-aureus* infection of the face, lips or nose was present in any patient below the age of twelve years. Hudson<sup>2</sup> reported a fatality in a patient of fourteen years of age. Incidentally, a number of surgeons, pathologists, pædiatricians, and medical men were questioned relative to the latter, and none recalled having seen a case below the age of twelve years.

The suddenness of the appearance of this condition, the rapid progress of the symptoms, the high mortality rate, the frequency of this condition from adolescence onward and the fact that healthy, well-nourished individuals are prone to this infection, with dramatic termination of life, makes this subject an important one. Dr. Walton Martin<sup>3</sup> asked the following questions: (a) What is the interpretation of this particular gravity of infection by similar organisms in certain cases? (b) Why had he five deaths only among eighty carbuncles of the neck and back, many among the old people, enfeebled, the diabetic, and seven deaths in carbuncle of the lip in persons all below forty-five years old? (c) Why had death followed promptly on admission? These questions have been present in the minds of many, and it becomes necessary to examine all the known factors in this condition.

*Anatomy and Physiology*—In proceeding with this phase, we must consider the skin, and the venous system from the anatomic as well as the physiologic view in order to appreciate what nature contributes to the gravity of the condition in question.

The skin of the face is unusually thin for protective covering of so important an area and is exceeded in thinness only by the skin of the eyelids and prepuce.<sup>4</sup> As a result of this peculiar anatomic characteristic it is interwoven with the underlying structures, as the muscle fibres, blood-vessels, lymphatics, and the unusual small amount of subcutaneous tissue. The skin in this area is extremely vascular, rich in glands and hair follicles. It is obvious that such important structures as the veins become here apparently superficial, more so than any localized important venous vessel or vessels elsewhere in the body. One of the main functions of the skin is its protective mechanism. The skin is so often the subject of staphylococcus infection for the following reasons: (a) The epidermal invaginations—the pilary follicles allow the entrance of and harboring of dirt and organisms. (b) It appears that the staphylococcus finds its natural home in the follicles, and it appears too, to have a special affinity for the skin, just as *Bacillus dysenteriae* has for the large bowel.<sup>5</sup>

The skin has some muscle fibres attached to its lowest layer and there is little connecting or subcutaneous tissue present. This is an important fact for the allowance of distention produced by any inflammatory material between the skin and the underlying structures. The main substance of the lips is made up of connective tissue and muscle fibres. There are nine muscles, one of which is a true sphincter. The orbicularis oris and the other eight are bilaterally placed, converging toward the sphincter, giving rise to a network of muscle fibres whose function is like the muscles of the extremities<sup>6</sup> hence, when the lips are moving, the muscle fibres are constricting the blood content, and thus assist in accelerating the blood flow into the general circulation.

The venous network of the face, lips, nose and cavernous sinus are united through a moderately complicated structure of superficial veins. The facial vein, which is the

is resistant to heat, cold, chemicals and can survive for weeks in dried pus. Its pathogenicity in man is evident as the simple rubbing of the organisms into the surface of unbroken skin, and will give rise to a boil and the introduction of a few cocci from a septic case into a wound may lead to a fatal pyæmia.<sup>12</sup> It is, however, characteristic in its ability to produce pyæmia, as well as an acute localized suppuration, especially in connection with skin and subcutaneous tissue, and from here spread and localize itself in independent tissues of the body.<sup>13</sup>

Immunity to staphylococci is not present in the blood as a rule. Immunity to a definite strain may be developed when the individual has been previously infected, as in multiple furunculosis, or by the use of a vaccine. It is a known fact that the body at times is unable to produce sufficient antibodies to ward off a localized or general infection. In many instances, there will be just sufficient antibodies, as well as a cellular response, to localize and hold an infection to its entrance point but while this is taking place, the organisms are still alive, and growing, but often with slight trauma such as cutting, squeezing, *etc.*, the bacteria enter the circulation and spread throughout the body. Severity of infection depends upon the following: (a) Resistance of the host, (b) virulence of the organism and quantity, (c) susceptibility, and (d) the specific responses of the body.<sup>1</sup>

*Pathologic Physiology*—A young man notices a small pimple on his cheek (nose or lips), probably the result of a scratch, contusion or cut. The adjacent skin area is swollen and painful, as result of the inflammatory distention. Three or four days pass the pimple has increased in size, the lower eyelid is beginning to swell, the face is swollen, the infected area is larger and appears to be "ripe" to the layman. He squeezes and expresses a little pus. A day or two later the condition either improves or the face becomes more painful, the eyelids more oedematous, the inflammation appears angry-looking, shooting pains in the head and severe headaches and fever. The mechanical pressure during the process of squeezing broke down nature's barrier of defense—the indurated circumscribed granulation tissue—and the organisms which were in the localized area, gradually increasing in virulence spread, producing a phlegmon. The facial vein becomes involved and a phlebitis follows. The primary focus (hair follicle) at this time extends through the skin layers to a circumscribed area of inflammation which is in the underlying tissue and important venous structures, and thus communicate directly with a vein or its branches. The result may be (a) a localized thrombophlebitis of the facial vein or (b) a minute erosion of the vessel communicating with the phlegmon. The facial vein, because of its patency and absence of valves, allows the inflammation to spread without any resistance in either direction, namely, upward toward the superior ophthalmic which enters the cavernous sinus, or downward to the deep facial which enters the pterygoid plexuses, and on to the cavernous sinus. The first direction is retrograde and the commonest form of spreading of this infection. At this stage the bacteria may enter the blood-stream either (a) through the minute erosion of the blood-vessel, or (b) due to a thrombus. The supply of bacteria to the circulation gives rise to a septicæmia with or without metastatic abscesses in other organs. The formed thrombus may (a) enlarge and extend through the entire length of the facial vein, thus obliterating the lumen of the vessel, (b)

the organism (staphylococcus) with surprising ease, if the primary source of infection is removed."

At the Lebanon Hospital, in thirty-four cases of infection of the neck, there was only one death, while in Doctor Martin's series of eighty infections of the neck, there were five deaths. In these two series, there were a fair number of the old, chronically ill, and feeble patients. The reason for the lower mortality in infections of the neck is the fact that the skin of the back of the neck is very thick, subcutaneous tissue is excessive and presents a greater barrier to the spread of the infection, and when it reaches the subcutaneous layer, the venous vessels are not as numerous and do not drain into or communicate with an important structure such as the cavernous sinus. However, death may occur with infections of the neck due to the virulence of the invading organisms and the lack of resistance of the host just as deaths do occur in pneumonia, diphtheria, *etc.* We can thus state that the organisms that have produced a severe carbuncle of the neck, with recovery if placed in the danger area of the face, most likely will present the usual picture described above with termination of life.

The fact that the hair follicles and sebaceous glands are not well developed until after puberty is the possible reason for the fact that furuncles or carbuncles of the face are not usually present before puberty.

From the primary focus, secondary pathologic complications may develop. The question arises, is the spreading of the primary infection through (a) the lumen of the veins, (b) the lymphatics, or (c) a combination of both? Lenhartz<sup>17</sup> cites cases to show that death may occur from a blood-stream infection, without any thrombophlebitis of the facial or ophthalmic veins, and admits the possibility of lymphatic and cellular routes. However, Doctor Martin commented as follows: "There is no record, however, of a careful dissection of the small veins (facial tributaries) of the face." The only communication between the face (lips and nose) and the skull is through the venous network, as described. The repeated post-mortem findings by numerous observers in a large percentage of cases have conclusively demonstrated that the facial vein and its tributaries must be the vein involved to lead the infection toward the skull. The erosion of a vessel without phlebitis does occur, as, for example, in tuberculous gland of the hilus of the lung, eroding a vessel, giving rise to a blood-stream infection. The absence of a visible thrombosis of a small tributary of the facial vein does not mean that there are no thrombi present. The size of a thrombus, whether it is visible or minute and only recognized by microscopic sections, does not influence the severity of a blood-stream infection. Therefore, the supply of bacteria to the blood-stream either due to a visible infected thrombus, macroscopic or microscopic in size, or through the erosion of a blood-vessel, will give the same clinical picture. The lymph from the skull, and from the face (lips and nose) does not flow through the same afferent vessels or nodes. The lymph can flow in only one direction, that is, toward the heart. Infections can spread through the lymphatics, but appear to be limited in this condition.

- <sup>5</sup> Dowling, Godfre B The Medical Press and Record, pp 380-381, London, November 10, 1926
- <sup>6</sup> Howell Text-book of Physiology, pp 520-521
- <sup>7</sup> Gray's Anatomy, pp 711-712
- <sup>8</sup> Cunningham Text-book of Anatomy, p 1003
- <sup>9</sup> Gray's Anatomy, p 777
- <sup>10</sup> Starling Human Physiology, p 1068
- <sup>11</sup> Hiss, and Zinsser Text-book of Bacteriology p 381
- <sup>12</sup> Dowling, Godfre B Medical Press and Record p 381, November 10, 1926
- <sup>13</sup> Park, and Williams Pathogenic Microorganisms, p 291
- <sup>14</sup> Rose, and Carless Manual of Surgery, p 59
- <sup>15</sup> Park, and William Pathogenic Microorganisms, p 158
- <sup>16</sup> Park, and Williams Pathogenic Microorganisms, p 293
- <sup>17</sup> Lenhartz, Hermann Die Septischen Erkrankungen, p 262, 1903
- <sup>18</sup> Powers, Charles A Philadelphia Med Jour vol VII, p 303 1901
- <sup>19</sup> Reverdin, Jacques Recherches sur les causes de la gravite particuliere des anthrax et des furoncles de la face, 1870
- <sup>20</sup> Risenbach, F J Ueber Maligne Gesichtsfurunkel und deren behandlung Archiv f klin chir, vol XXVII, p 715, 1905
- <sup>21</sup> Lang, O Lipfurunkel Nederlindich Tijdschrift voor Geneeskunde, vol LXIV, p 2495, 1902
- <sup>22</sup> Keppler Zur Behandlung der Malignen Gesichts furunkel Munch Med Wochensch, p 337, 1910
- <sup>23</sup> Wrede Konservative Behandlung der Gesichts Furunkel Munch Med Wochensch, p 1539, 1919



blood-vessels (Figs 3 and 4) Again the source of the bleeding was not discovered. The fourth operation was similar to the third, but in view of the smaller size of the hematoma, not so extensive.

The recurring hæmorrhages into the pachydermatocele in this case indicated the seriousness of this complication, for they repeatedly threatened the life of the patient. The surgical problem of preventing its recurrence was not solved. The total excision of the pachydermatocele was not seriously contemplated for because of its size and position its total removal would have



FIG 1—Anterior view of patient showing large nevus on thigh and diffuse pigmentation over the remainder of the body.



FIG 2—Posterior view of patient showing bathing trunk nevus and large tumor (pachydermatocele with hematoma) involving lumbar region and buttocks.

been difficult and hazardous. The case remained unique in our experience until 1924 when a patient presented himself who not only illustrated the complication of hæmorrhage but the complication of infection in a large pachydermatocele. His story follows.

CASE II—A. H. Nos. J-9375, K-1368, N-6123, N-7783, O-5137. A white man aged forty years, was admitted to the Cincinnati General Hospital, December 29, 1924, because of the rapid swelling of a tumor of the left thigh following an injury three

its present proportions Three days before admission he fell a short distance, striking his left hip and bruising the tumor A few moments after the injury the tumor over his hip rapidly increased in size and then more slowly enlarged until his admission to the hospital It became painful and over its most prominent portion showed a bluish-black

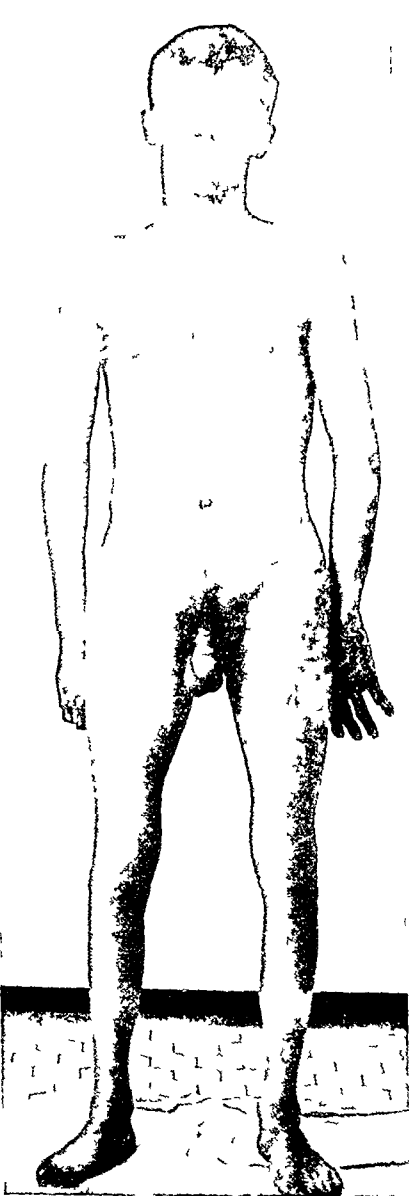


FIG 5—Anterior view of Case II showing pigmentation over the body This photograph was taken after the removal of the pachydermatocele

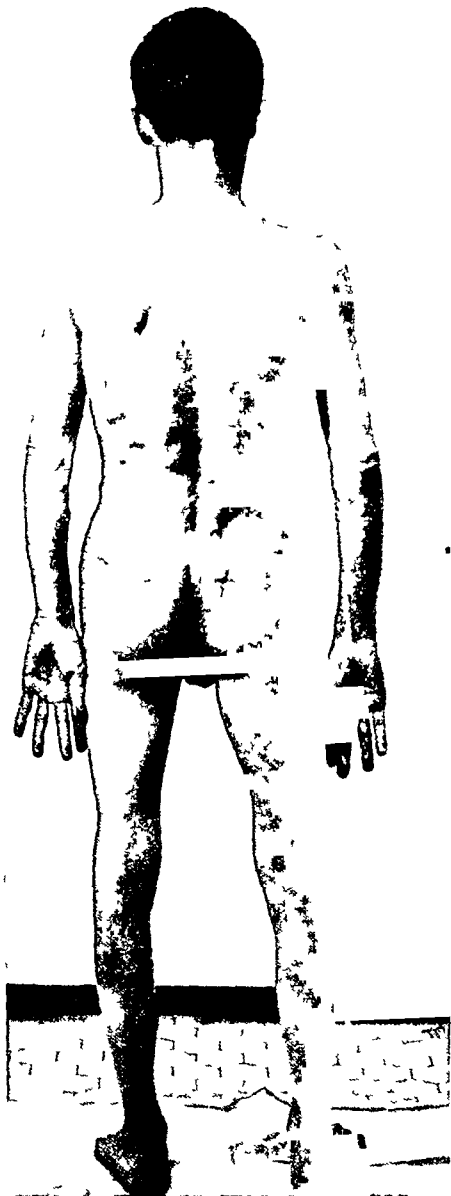


FIG 6—Posterior view of Case II showing the pigmentation and small cutaneous tumors The photograph was taken after the removal of the pachydermatocele and the tumor of the right thigh

discoloration of the skin At the place of greatest discoloration the skin broke down and there was a discharge of dark blood and blood clots from the opening There is no history of shock following the injury

There appeared, however, on the thirty-first day of his admission a small secondary infection with abscess formation over his right sacrum (the pachydermatocele was on the opposite side). The abscess was opened and cultures from the pus showed streptococci. Wishing to be sure that there was no other focus of infection the patient was subjected repeatedly to every sort of examination always with negative results. Blood cultures were always negative.

After this bout of illness the patient was quite ready to have the pachydermatocele removed. He was, however, greatly weakened and emaciated as a result of his protracted fever. Moreover we did not wish to operate too soon after the infection. The operation was therefore postponed for over a month.

*Operation*—April 25, 1925. The entire tumor was encircled by an incision carried down to the deep fascia of the thigh. The greater part of the tumor lay superficial to the deep fascia and could readily be stripped off from this structure. Here and there, however, the tumor penetrated the fascia and extended more deeply into and between the muscles and in these locations probably some of the tumor was left behind. The tumor presented the usual gelatinous appearance and contained numerous large and extremely thin-walled blood-vessels. Its removal however was not attended with difficulties or considerable hemorrhage. The huge wound was drawn together above and below as much as possible and sutured. There was left a large defect which later was successfully skin grafted (Fig. 8).

The patient was discharged from the hospital on May 27, 1925, apparently well. His subsequent history does not concern our present subject, but it may be said that two years after the successful removal of the pachydermatocele he was re-admitted with a large tumor of the posterior surface of the right thigh associated with great pain. This was found at operation to arise from the sheath of the sciatic nerve and was apparently completely removed. It proved to be a sarcoma and following operation a series of X-ray treatments was given. A year after its removal he returned with local recurrences, two of which lay beneath the scar. A high thigh amputation was done because of great pain. For another year he was in fair health, then returned with a local recurrence in the amputation stump and generalized sarcomatous metastases. He remained in the hospital until his death.

*Comments*—The hæmorrhage into the pachydermatocele in this case was of no great moment but the subsequent infection within the tumor presented a difficult problem. This infection spread rapidly throughout the tumor and caused a great increase in its size. The furrowed skin became red, thinned and shiny, the whole tumor mass boggy and œdematous. The usual measures, such as hot compresses of isotonic or hypertonic salt, of aluminum acetate, of epsom salts, etc., had no effect whatever upon the infection. Moreover, after the application of such compresses for forty-eight hours the skin always became macerated and threatened to break down. Dry heat had no more effect. Incisions into the mass seemed contraindicated. Had incisions been contemplated it would have been difficult to decide where to make them, moreover, it seemed very problematical what they would accomplish. One could imagine merely a protruding mass of œdematous gelatinous tissue filling the incision as soon as it was made, with the possibility of serious hæmorrhage from the incised tissue. To observe an infection progress for thirty-five days with the temperature and leucocytes mounting and to be at a loss for measures to check it is an unhappy situation, and on several occasions we were on the point of deliberately excising the entire mass during

*Comment*—This patient entered the hospital with all the signs of an acute, severe hæmorrhage, and died within four hours after his admission. The rapid increase in the size of the tumor with bluish discoloration makes it quite evident that the patient bled to death into the pachydermatocele. This is the first case in our experience of a fatal outcome from hæmorrhage.

Before our fourth and last case came under observation there appeared in the *J A M A*, July 17, 1926, a note by Carrington and Bullitt, describing a case in which a hæmorrhage had occurred in a pachydermatocele of von Recklinghausen's disease. They had failed to find a record of a similar case, having apparently overlooked the case

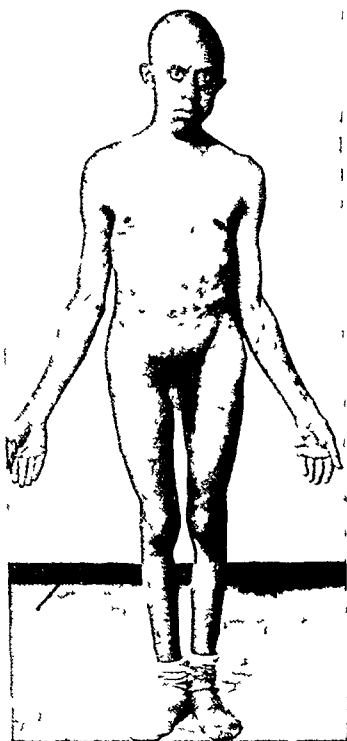


FIG 9—Anterior view of Case IV showing pigmentation and cutaneous tumors. Photograph taken after the evacuation of the temporal hæmatoma.

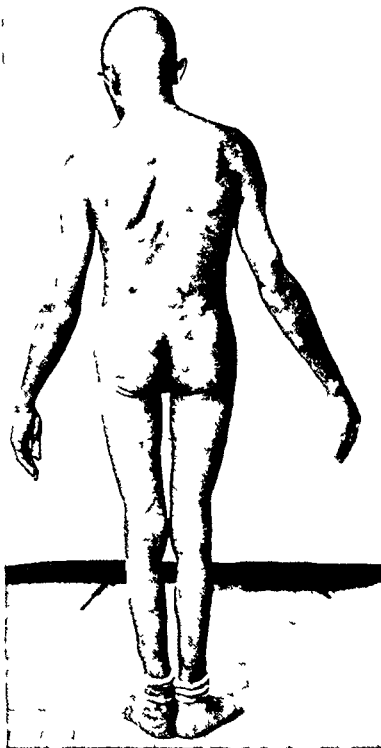


FIG 10—Posterior view of Case IV showing the areas of pigmentation and cutaneous tumors. This photograph also was taken after the evacuation of the temporal hæmatoma.



FIG 12—Lateral view of Case IV. The photograph was taken after the evacuation of the hæmatoma. The tumor present before operation is outlined on the scalp.

described by one of us in 1917. This patient was a colored man, twenty-two years of age, who since childhood had had numerous small nodules scattered over his body and several of larger size, the largest, the size of an orange located on the right flank. On the morning of July 28, 1925, he was struck upon the right flank by a falling tree. Thirty-six hours after the trauma a swelling involving the pachydermatocele appeared and within two hours increased to the size of his head. When seen there was a mass upon the right side extending from "the lower costal margin to the crest of the ilium and from the erector spinæ muscles forward to a line mid-way of Poupart's ligament." The mass was soft and fluctuant. The patient's general condition was good and he apparently quite failed to show the symptoms of hæmorrhage seen in two of our cases. An operation was performed August 3, 1925, and an incision into the mass

over the left temporal region. It displaced the ear downward and extended sufficiently far forward to close the left eye. The skin over the tumor was tense, rather shiny, but did not present the usual appearances of a pachydermatocele. The swelling was somewhat tender and was definitely fluctuant. An X-ray of the skull was negative. The patient's temperature was  $101^{\circ}$ , and his leucocytes 11,500. During the patient's stay (two days) in the hospital before operation was undertaken, the mass very definitely increased in size. In view of our former experiences, the diagnosis of hemorrhage into a tumor of von Recklinghausen's disease was made, although in this case a definite external tumor resembling a pachydermatocele was not present.

*Operation*—September 21, 1926, (Dr. Max Zinninger). A vertical incision was made over the tumor mass in front of the ear and parallel to the fibres of the temporal muscle. On dividing the galea the temporal muscle appeared greatly thickened, dark red in color and apparently infiltrated with blood. The muscle was incised and a large amount of blood clot evacuated. The swelling consisted of a huge hematoma which lay between the temporal muscle and the periosteum covering the bone. The bone was nowhere exposed. After the fluid and clotted blood were evacuated there appeared a large cavity lined with a gelatinous, dark, reddish tissue of considerable thickness and definitely resembling the myxomatous tissue occurring in pachydermatocèles. A considerable portion of this gelatinous tissue was excised for microscopic section. No source of bleeding was found. The wound was closed without drainage.

The microscopic section of the tissue excised showed a very loosely formed, oedematous-appearing tissue, containing numerous fibrous-tissue cells, with here and there an attenuated strand of muscle. Some of the cells bore a resemblance to the glia cells. The blood-vessels contained in this tissue were extremely numerous, the vessel walls varying in thickness, but the majority being extremely thin-walled (Fig. 11). Strands of fibres resembling branching nerve fibres were observed. The pathological diagnosis was neurofibroma\*.

The patient made a satisfactory recovery. The wound healed *per primam*. The swelling decreased in size and eventually the temporal region became quite flat. Unfortunately a photograph of the patient before operation was not taken. The lateral view of the patient (Fig. 12) taken after operation shows the outline of the tumor mass marked upon the scalp with a pencil.

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\*Dr. M. M. Zinninger states that during his stay in China he observed two cases of von Recklinghausen's disease in which the entire temporal muscle was involved in the tumor. The muscle was 2 inches thick, pale, oedematous, gelatinous and myxomatous in appearance. There was no separation between the galea of the scalp and the muscle, and the temporal fascia was not recognizable as such. In the above case the temporal muscle was thickened but not involved in the sense that Zinninger's Chinese cases were

73.8 per cent of those occurring in the colored race occurred in these same decades. This age incidence is comparable to that obtained in the cases of empyema reported by Binney,<sup>15</sup> Wilensky,<sup>16</sup> and Foster,<sup>17</sup> who found that 74.9 per cent, 76.7 per cent, and 77.03 per cent occurred in the second, third, and fourth decades, respectively, whereas in our entire series, 78.9 per cent occurred in the second, third, and fourth decades. The mortality rate in our series was highest in those cases occurring after fifty-one years of age (43.6 per cent). In the fifth decade there were no deaths. There were, however, only fifteen cases. The mortality rate in the second, third, and fourth decades was 12.5 per cent, 13.6 per cent, and 16 per cent, respectively. The average ages of all patients was 31.5 years, the average age in the white race, 30 years, and that in the colored, 33 years. The average age of those which were improved, i.e., discharged from the hospital with draining sinuses, was 29 years in the entire series, in the white race, 26 years, and in the colored race, 32 years. The average age of those which recovered, i.e., discharged from the hospital with a healed wound and with no evidence of empyema, was 30 years, in the white, 27 years, and in the colored 33 years. The average age of those patients who died was 34.1 years, in the white, 34 years, and in the colored, 34.3 years.

Acute empyema thoracis usually follows a pneumonic process and as a rule follows lobar pneumonia. During influenzal epidemics, however, a lobular variety of pneumonia is the most frequent cause of empyema. The antecedent lesion was stated in 110 of the 124 Charity Hospital cases. Lobar pneumonia was the cause of the empyema in sixty-eight (61.9 per cent), influenza in twenty (18.1 per cent), tuberculosis in fourteen (12.8 per cent), lung abscess in six (5.5 per cent), a metastatic lesion in one (0.9 per cent), and a stab wound of the thorax in one (0.9 per cent). There was relatively little difference between the two races, except that tuberculosis was the underlying lesion in a higher percentage in the colored (19.7 per cent) than in the white race (8.7 per cent). Lung abscess, however, occurred more frequently in the white race than in the colored race. The etiology in our series does not differ materially from the series of cases reported by Peck and Cave,<sup>18</sup> Ganz,<sup>19</sup> and Binney<sup>15</sup> with the exception that a relatively larger percentage of cases followed influenza in the Charity Hospital series than in the other groups. The average interval between the onset of pneumonia and the onset of the empyema was thirteen and a half days, the maximum being sixty days, and the minimum, one day. There was practically no difference between the two races. The average interval between the onset of the empyema and the time of operation was fifteen days, the maximum being forty-nine and the minimum being one day.

*Symptoms and Signs*—Of the 124 patients, ninety-eight (79.3 per cent) complained of pain. Only one (0.8 per cent) had no pain and in twenty-five (20.1 per cent) it was not stated whether the patient had pain or not. Sixty-five (81.25 per cent) of the eighty white patients and thirty-three (75 per cent) of the forty-four colored patients complained of pain. Of the 124

higher leucocytosis existed in the thirty-six white patients (21,791 with 84 per cent polymorphonuclear leucocytes) than in the twenty-six colored patients (18,072 with 82 per cent polymorphonuclear leucocytes) in which a leucocyte count was made

In the series empyema occurred on the right and left sides with equal frequency, sixty-eight times each, in five cases there was a bilateral process. The mortality rate was somewhat higher in the cases with right-sided empyema (17.16 per cent) than in those in which the left side was involved (10.3 per cent). However, in the colored race, the mortality in left-sided empyema (33.3 per cent) was definitely higher than in the right-sided processes (5 per cent), and in the white race the mortality was higher in right-sided (13.16 per cent) than in left-sided lesions (3.9 per cent). In Rienhoff and Davison's<sup>11</sup> series the mortality rate was almost twice as high in left-sided as in right-sided empyemas. In Farr and Levine's<sup>20</sup> series of cases right-sided and left-sided empyemas had 16 per cent and 24 per cent mortality rates, respectively. On the other hand, in the cases reported by Beust<sup>21</sup> right-sided empyemas were associated with a mortality rate of 29 per cent, whereas of the patients with left-sided empyema, 13.6 per cent died. In a series of cases collected from the literature and including the Charity Hospital series the right side was involved in 435, the left side in 525, and the process was bilateral in twenty-seven.

Of utmost importance as regards the treatment and prognosis in acute empyema is the type of empyema. As emphasized by the Empyema Commission<sup>1</sup> and other observers, the synpneumonic type of empyema, *i.e.*, the empyema which occurs concomitantly with the pneumonic process, is associated with a higher mortality than other types of empyema. On the other hand, the metapneumonic type, that in which the empyemic process follows the subsidence of the pneumonic process, offers a much better prognosis. In 111 cases of the present series, the type of empyema was stated. It was of the metapneumonic variety in sixty-seven cases (60.3 per cent), of the synpneumonic type in twenty-four (21.6 per cent), of a tuberculous nature in fourteen (12.6 per cent), and staphylococcic in six (5.4 per cent). Rather significant is the relatively high percentage of acute tuberculous (secondarily infected) empyemata occurring in the negro, 20.5 per cent as compared with 8.3 per cent in the white.

Of the sixty-seven cases of metapneumonic empyema improvement occurred in fifty-three (79.1 per cent), recovery in nine (13.4 per cent), and death in five (7.4 per cent). There was little difference between the two races except that the metapneumonic variety occurred in 63.6 per cent of the colored patients and 53.7 per cent of the white patients. Of the twenty-four cases in which synpneumonic empyema was present, seventeen (21.25 per cent of all the white patients) occurred in the white race, and seven (15.9 per cent of all the colored patients) in the colored. Of the twenty-four cases of synpneumonic empyema fourteen (58.4 per cent) improved, four (16.6 per cent) recovered, and six (25 per cent) died. Of

Of this number fifty-six (62.2 per cent) showed pneumococci, sixteen (17.5 per cent) showed streptococci, six (6.6 per cent) showed staphylococci, and twelve (13.2 per cent) were sterile. Of the fifty-six patients whose pleural fluid contained pneumococci, forty-three (76.7 per cent) improved, eight (14.2 per cent) recovered, and five (8.9 per cent) died. Of the sixteen with streptococci seven (43.7 per cent) improved, three (18.7 per cent) recovered, and six (37.5 per cent) died. Of the six with staphylococci five (83.3 per cent) improved and one (16.6 per cent) recovered, whereas of the twelve patients with sterile pleural exudates nine (75 per cent) improved and three (25 per cent) died.

*The Treatment of Empyema*—The treatment of empyema should accomplish the following: 1, relief of toxæmia, 2, relief of increased intrathoracic pressure, 3, evacuation of intrapleural fluid, 4, establishment of the function of the lungs by causing reexpansion, 5, prevention of the condition from becoming chronic.

Toxæmia may be lessened to a considerable extent by the cautious removal of pleural fluid without opening new avenues for its absorption. The general care of patients suffering with acute empyema should not be neglected. The question of diet has been emphasized repeatedly. Bell<sup>2</sup> showed that unless attention is paid to diet these patients are likely to have a negative nitrogen balance which in adults may amount to as much as 21 grams a day. His investigation showed that if a diet of from 1,500 to 1,700 calories a day was maintained that a negative nitrogen balance always existed, the nitrogen loss being principally in the urine (from 20 to 30 grams a day), whereas only about 2 grams daily were lost in the pleural exudate. The Empyema Commission<sup>1</sup> advocated a basal diet of from 3,300 to 3,500 calories per day in acute empyema.

Intrathoracic pressure may produce a kinking of the large vessels, especially of the inferior vena cava. As a result of collapse of the lung, the pressure within the lesser circulation is definitely increased. Increased intrathoracic pressure is best treated by aspiration, which should be employed in all types of empyema. Aspiration should always be used as a diagnostic procedure before any other type of surgical therapy is attempted. It is indeed the only method which can be used in the synpneumonic type, especially that due to streptococci, before the fluid becomes purulent.

Evacuation of the pleural fluid may be accomplished in a number of different ways. One is impressed in a review of the literature by the diversity of opinion concerning the proper type of treatment. Prior to the World War, the most common form of therapy was "open" thoracotomy by means of rib resection. As a result of the work of the Empyema Commission<sup>1</sup> and especially the researches of Graham and Bell<sup>2</sup> more conservative procedures became popular, especially in the streptococcic empyemas. At the present time even though a large number of surgeons prefer an "open" operation, a still larger number employ some type of "closed" drainage, especially supplemented with irrigation of the pleural cavity. In the synpneumonic type of empyema, particularly the streptococcic variety, it is imperative that the



Danna employed a small intercostal incision through which fibrinous exudate could be evacuated, following which no attempt was made to keep the wound open. In our analysis of the Charity Hospital series, aspiration of the pleural fluid combined with air injection was used in twenty-nine cases, two of which subsequently had rib resection. Many of these patients were under Danna's care and are included in his previous reports. Of the twenty-nine cases, thirteen (44·8 per cent) were improved, ten (34·4 per cent) recovered, three (10·3 per cent) were unimproved and three (10·3 per cent) died. In comparing the two races considerable difference in mortality is seen to exist there being a 33·3 per cent and a 4·3 per cent mortality in the colored and white races, respectively. This discrepancy may, however, be due to the comparatively small number of cases. Of eleven cases of metapneumonic empyema, all white, treated by repeated aspirations associated with air injection, six (54·5 per cent) improved and five (45·4 per cent) recovered. Five cases of synpneumonic empyema were treated by aspiration, one by aspiration alone and four by aspiration together with air injection. One of these patients improved, two recovered, and two died. Two cases of tuberculous empyema were treated by aspiration plus air injection, one of which recovered and one died. Two cases of staphylococcic empyema were treated by air injection plus aspiration, one of which recovered and the other was improved. Aspiration plus air injection was used in twenty instances of empyema with purulent fluid, resulting in eleven recoveries, eight improvements, and one death. Two patients with serous exudate in the pleural cavity recovered following aspiration alone and one recovered following aspiration plus air injection. The average number of aspirations and air injections was four the maximum fifteen, and the minimum one. The average amount of pus evacuated before air injection was 529 cubic centimetres, the maximum 2,800 cubic centimetres, and the minimum 15 cubic centimetres. The average amount of air injected after aspiration of pus was 546 cubic centimetres, the maximum 2,300 cubic centimetres and the minimum 35 cubic centimetres.

Intercostal drainage was used in forty-one cases five of which were treated by preliminary aspiration. Of these forty-one cases, thirty-three (80·5 per cent) improved, three (7·3 per cent) recovered, and five (12·2 per cent) died. One of these patients subsequently had a rib resection. An intercostal drainage was performed in twenty-five instances of metapneumonic empyema, eighteen (72 per cent) were improved, four (16 per cent) recovered, and three (12 per cent) died. There was little difference between the two races except that the mortality rate in the colored was lower (8·3 per cent) than in the white (15·3 per cent). One of these patients subsequently had a rib resection. Intercostal drainage was associated with open drainage four times. Each patient recovered. It was associated with closed drainage in twenty-one instances, of which fourteen were improved, four recovered, and three died. Four cases of synpneumonic empyema were treated by intercostal drainage, all of which were improved. Two of these were treated with closed drainage and two with open drainage. One patient subsequently had a rib resection. One case in a negro, in which intercostal

those obtained by intercostal drainage (12.1 per cent) and rib resection (13.6 per cent). The highest percentage of good results, *i e.*, those recovering and improved, was obtained by intercostal drainage (87.7 per cent) and rib resection (84.8 per cent).

There is considerable controversy among authorities concerning the danger of the production of an open pneumothorax in the treatment of acute empyema. As mentioned and emphasized above, open pneumothorax is to be avoided early in the course of the synpneumonic type of empyema, especially the streptococcic variety. Concerning the relative merits of the "open" and "closed" drainage, it might be said, in general, that everything else being equal "closed" drainage is theoretically the ideal procedure in that it is certainly much more physiologic than "open" drainage. Ideally closed drainage results in an evacuation of the pleural contents without the production of an open pneumothorax, maintaining at all times the normal negative pressure within the pleural cavity and in this way favors the reexpansion of the lung, which results in its early return of function. Practically, however, ideally as "closed" drainage may appear, it has very definite disadvantages. It is undoubtedly the ideal method of treatment in those institutions in which there is adequate help available in order that the drainage system may be kept open and functioning. However, there is a probability especially in the pneumococcic type of empyema, that the system may become clogged by masses of fibrin. Because of this, "open" thoracotomy accomplished by rib resection is the better procedure in those cases in which proper supervision is not possible. It is a more "fool-proof" method. In the Charity Hospital series of cases, forty-eight (45.2 per cent of those cases in which the type of drainage was stated) were treated by open drainage, of which number thirty-seven (77 per cent) were improved, three (6.2 per cent) recovered, one (2.1 per cent) were unimproved, and seven (14.5 per cent) died. The most significant difference between the races was that apparently the negro did not stand "open" drainage so well as did the white patient. The mortality following open drainage in the colored race was 26.3 per cent as compared with 6.9 per cent in the white. The number of cases, however, is small. Fifty-seven cases (54.2 per cent of those cases in which the type of drainage was stated) were treated by closed drainage, of which number twenty-five had an associated closed pneumothorax. Four of these patients subsequently had open drainage performed. Of the fifty-seven, forty-four (77.2 per cent) improved, six (10.5 per cent) recovered, and seven (12.2 per cent) died. The mortality following closed drainage in the Charity Hospital series was slightly lower than in those cases in which open drainage was employed.

The type of anæsthetic employed was local infiltration in 100 cases, ethylene in four, and in twenty the type of anæsthetic was not stated.

Post-operatively, irrigation was employed in sixty-six patients, forty-one in the white and twenty-five in the colored patients. No irrigation was used in eight instances in the white race and in four of the colored. It is not stated whether irrigation was used in thirty-one cases of the white race and in nineteen of the colored. Of the forty-one times irrigation was used in

The signs and symptoms presented by the patients in the present series in order of their frequency were as follows 1, dullness on percussion, 2, pain, 3, cough, 4, limitation of thoracic movement, 5, absence of breath sounds, 6, expectoration, and 7, cardiac displacement

Right-sided and left-sided empyemas occurred with equal frequency In the colored race the mortality was higher in left-sided (33.3 per cent) than in right-sided processes (5 per cent), whereas in the white the mortality in the right- and left-sided lesions was 13.16 per cent and 3.19 per cent, respectively

Empyema was of the metapneumonic variety in 60.3 per cent, of the synpneumonic type in 21.6 per cent, tuberculous in 12.6 per cent, and staphylococcic in 5.4 per cent Improvement and recovery occurred in 92.24 per cent of the metapneumonic cases, in 75 per cent of the synpneumonic cases, and in all the staphylococcic cases Improvement occurred in 71 per cent of the tuberculous cases

The pleural fluid was purulent in 79.03 per cent of the cases (mortality rate 7.3 per cent), serous in 3.98 per cent (mortality rate 20 per cent), and hæmorrhagic in 4.83 per cent (mortality rate 100 per cent)

In the treatment of empyema in the present series of cases aspiration alone was used in 8.8 per cent of the cases, aspiration plus air injection in 21.5 per cent, intercostal drainage in 30.3 per cent, and rib resection in 39.2 per cent Aspiration alone resulted in improvement or recovery in 41.7 per cent of the cases in which it was employed Aspiration of the pleural exudate combined with air injection gave improvement or recovery in 79.2 per cent of the cases in which it was used There was a mortality rate of 10.3 per cent Intercostal drainage resulted in improvement in 80.5 per cent, recovery in 7.3 per cent and death in 12.2 per cent Rib resection gave the following results 79.2 per cent were improved, 5.2 per cent recovered, and 13.2 per cent died The lowest mortality, 10.3 per cent, was obtained by aspiration of the pleural contents combined with an injection

Open drainage was employed in 45.2 per cent of the cases, of which number 14.5 per cent died and 83.2 per cent were improved or recovered The mortality rate in the negro following open drainage was 26.3 per cent, whereas that in the white patients was 6.9 per cent Closed drainage was used in 54.2 per cent, of which number 12.2 per cent died and 87.7 per cent were improved or recovered Complications developed in 5.8 per cent of the cases Of the complications, 62.5 per cent occurred in the white race Acute nephritis, representing 21.8 per cent of all complications, was the most frequent complication encountered Of the complications, bronchial fistula and abscess of the chest wall represented 15.6 per cent and 9.3 per cent, respectively There was a mortality rate in the entire group of 15.3 per cent, in the white patients of 10 per cent, and in the negro patients of 25 per cent Of the entire group, 82.2 per cent were either improved or recovered

# THE TREATMENT OF LUNG ABSCESS AND EMPYÆMA BY PACKING\*

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FROM THE SURGICAL SERVICE OF THE HARLEM HOSPITAL

IN SUBMITTING this procedure for consideration, criticism is expected. No one has been more critical than ourselves. In general, no method of treatment in surgery produces 100 per cent of cures. It must be realized that the method is in its infancy, and that the number of cases is comparatively small, and that changes will be made and have been made in the technic and in the selection and the preparation of cases before operation. Nevertheless, the all-round superiority of the method over other forms of treatment is unquestionable to those who have observed it.

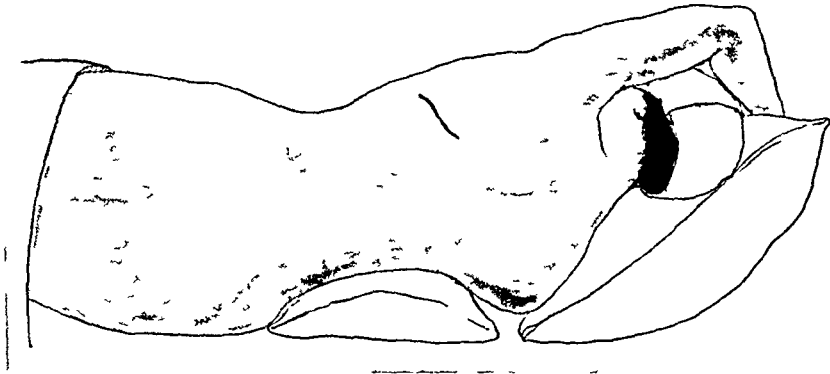


FIG. 1.—The patient is placed on the side opposite the lesion. The incision is made as illustrated above in the eighth interspace for a total empyæma, but in a case of partial empyæma the incision is made over the lesion.

*The Procedure*—The patient is placed upon the unaffected side with the chest resting upon a small pillow. The arm of the affected side is drawn up over the head (Fig. 1). If the empyæma is localized, the incision is made at the dependent portion of the focus. If, however, the empyæma is diffuse, as is usually the case, a four-inch incision is made in the direction of the ribs along the eighth interspace in the subscapular region. About two-and-one-half inches of the eighth and ninth ribs are resected subperiosteally. The intercostal muscles and vessels are removed *en masse* from the chest-wall after being ligated for a distance corresponding to the length of the ribs resected.

An aspirating needle is inserted into the pleural cavity. If pus is obtained, a grooved director is plunged in alongside the needle. The opening is gradually enlarged until it admits the tip of the aspirating apparatus. As

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\* Read before the joint meeting of the Philadelphia Academy of Surgery and the New York Surgical Society, February 11, 1931.

*Lung Abscess*—Some cases of lung abscess are cured by postural drainage and by the use of the bronchoscope in the hands of a well-trained bronchoscopist. When it is obvious that these cases are not cured, and we believe few are by the use of the bronchoscope, they should be submitted to surgical treatment at not too late a date. Three cases of lung abscess which had ruptured into the pleural cavity came to our attention after surgical treatment had been delayed. A case of lung abscess which had been treated by bronchoscopy developed a septicaemia with metastatic foci in the elbow, knee and ankle with various subcutaneous infections.

One of the best adjuncts to the successful surgical treatment of lung abscess has resulted from the coordination of the work of the X-ray and the medical men. Through their efforts the line of incision has almost always been definitely localized. Their work has also shown that all lung abscesses are at or very close to the periphery. The same method of tight packing with the elimination of tubes has been employed. In cases of multilocular abscess the cavity is converted into one. An empyæma has never been produced during this treatment.

*Post-operative Care*—In the series presented, the packing was removed in from one to six days, although most commonly in from one to four days. Without exception the pleural surfaces, visceral and parietal, presented a smooth, clean, healthy appearance. The lung surface was pinkish and elastic. A few vigorous coughs expanded the lung to within an inch of the parietal pleura. Through the large thoracotomy wound the interesting mechanism of closure of the pleural cavity easily could be observed. Contrary to the common conception the lung on the side of the open pleural cavity expands with expiration. Coughing is the most forcible form of expiration and causes the lung to expand and fill the pleural cavity more than any other form of pulmonary exercise. The comparative inefficiency of blow bottles easily may be observed through the thoracotomy wound. Blow bottles are used continually, however but, in addition advantage has been taken of the observation of the value of coughing. Patients are instructed to cough every hour until tired. In the case of the type of patient found in a municipal hospital this is often difficult, but in the instances in which there is cooperation the result is encouraging.

In normal inspiration and expiration as seen through the large operative opening into the pleura the excursions of the lung are extremely small, so much so that the impression is obtained that it would be impossible to expand the lung sufficiently to fill the pleural cavity without some form of pulmonary exercise.

In addition to the effect of forced expiration another important factor in cure may be observed through the large thoracotomy wound. In packing the pleural cavity, stress is laid upon inserting the packing into the sulcus between the lung and parietal wall. Closing this sulcus is important since obliteration of the open pleural cavity starts at this point. With each dressing the sulcus

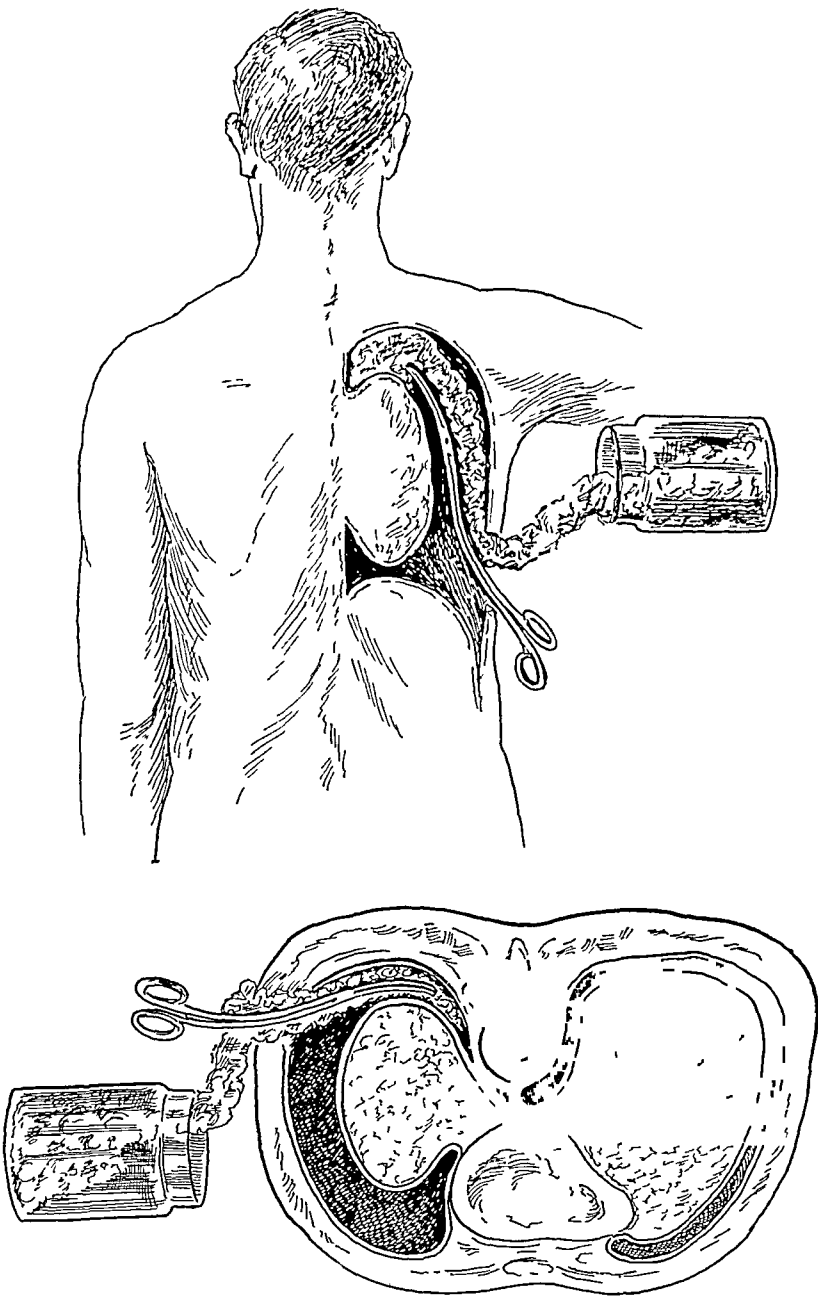


FIG 5 —Iodoform gauze packing is then inserted starting at the apex and proceeding downward until the entire cavity is tightly packed

should be felt that this orifice will not close. As a matter of fact, toward the end of the treatment it may be found necessary to keep it open, so rapidly does granulation tissue tend to obliterate it. Probably the size of the orifice most beneficial for closure of the pleural cavity and for drainage is approximately three-fourths of an inch in diameter. This may be obtained by strapping the skin of the wound loosely or by plugging the orifice with gauze down to the pleural cavity. Although the gauze corks the mouth of the cavity it is not air-tight and allows for the flow of air in and out of the pleural cavity with movements of the lung. When the orifice tends to close before the lung is completely expanded it may be kept open by the daily insertion of the gloved finger.

In the post-operative care of the patient the administration of fluids is extremely important, by mouth and intravenously. Saline solution is usually employed. Glucose intravenously in our experience has frequently been the cause of chills. It is never used by hypodermoclysis. Transfusions have been used freely, particularly in the cases which showed varying degrees of collapse. A high-caloric diet is maintained, including plenty of whisky, especially to those who are habitual drinkers. The patient is propped up in bed but is gotten out as soon as his condition allows and is urged to move about and sit out-of-doors when the weather permits.

*A Consideration of Deaths Following Operation*—The ages at death were Two, three, six, eighteen, twenty, twenty-three, twenty-nine, thirty-eight, forty and forty-two years of age. It will be observed that there were no deaths in patients of advanced age.

Two patients who died had a chronic active pulmonary tuberculosis and died of shock and cardiac failure, respectively four and fifteen days after operation. At the time of death the pleural cavities were clean.

Three patients who died had a bacteraemia before operation. Two of these were complicated cases. One had a subphrenic abscess which communicated with the empyæma cavity. The empyæma was probably secondary and a later manifestation of the subphrenic infection. Another was admitted with a diagnosis of gangrene of the leg and bronchitis. The dorsum of the foot and the leg was the seat of a deep infection and was bathed in pus of the extremely foul-smelling type, characteristic of lung abscess. There was an abscess over the tibia which contained gas and the same ill-smelling pus. Fluid developed in the pleural cavity, which clear at first, became thick and more foul. This was also characteristic of the pus found in lung abscesses. Whether the so-called bronchitis found on admission was really a long-standing lung abscess and the leg infection a metastasis from it, or whether the lung changes were secondary to the leg infection was not determined. The patient went on to rapid termination presenting at all times the picture of marked sepsis.

One patient had a necrosis with sloughing of the entire middle lobe of the lung and collapse of the lower lobe on the right side. The packing completely cleaned up the necrosed lobe and the accompanying empyæma in four

losis, of whom two died (Unfortunately it is not recorded whether or not the empyemata were tuberculous )

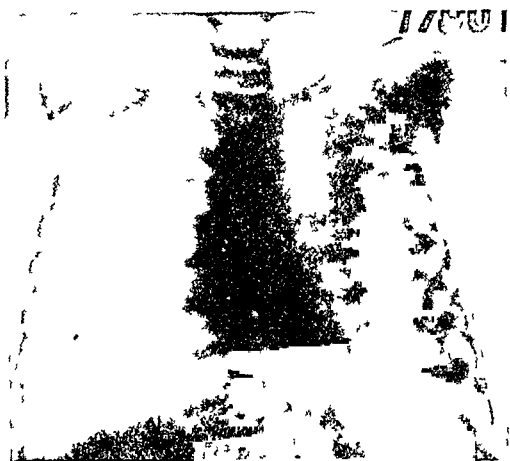


FIG 11



FIG 12

FIG 11—William C. A case of postpneumonic empyema. There is a diffuse shadow over the left lung. Thick pus was aspirated in the eighth interspace posteriorly, below the scapula and operation was performed at this point. A small, localized empyema was found and treated by packing. October 16, 1930.

FIG 12—William C. The small light area at the base indicates the small localized empyema evacuated at the first operation but reveals the diffuse shadow above it. Accordingly, another operation was performed to evacuate this empyema which was separated from the one below it and the packing treatment was instituted. A second operation was considered preferable to breaking down the septum between the cavities because in the lower one the lung had already expanded filling the cavity. October 27, 1930.



FIG 13

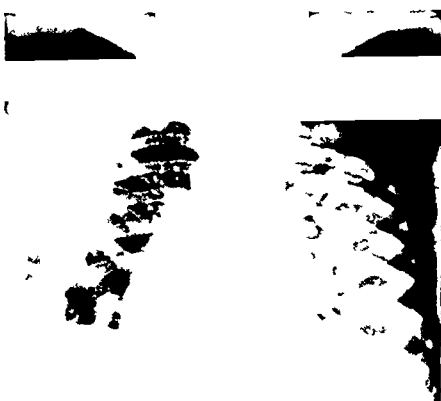


FIG 14

FIG 13—William C. The upper portion of the left chest is clear while the lower portion shows the shadow of thickened pleura. The gauze has been removed from both cavities and the lung has completely expanded. November 13, 1930.

FIG 14—William C. The wounds are closed granulating. There is still some thickened pleura. November 22, 1930.

Even though the packing method is considered the best at our disposal, some of the deaths seem to indicate that it should not be immediately applied to all cases without due consideration. Probably the method of approach to these few cases should be changed. Perhaps in the case of those extremely sick patients they may be tided over by frequent aspirations of pus and then



CASE V—A Q, colored, male, aged twenty-eight years Days ill before operation—? Admission diagnosis—Lobar pneumonia Type of pneumonia—I Anesthesia—Local Bacteriology of chest fluid—Pneumococcus Number of packings—Nine Days of elevated temperature post-operative—Thirteen Days in bed post-operative—Seventeen Remarks—Discharged healed

CASE VI—C P, colored, male, aged twenty-nine years Days ill before operation—One year Admission diagnosis—Chronic empyema Anesthesia—Local Bacteriology of chest fluid—? Number of packings—Eleven Days of elevated temperature post-operative—Eleven Days in bed post-operative—Twelve Remarks—Healing slow End-result good Seen one year later

CASE VII—C H, colored, male, aged twenty-four years Days ill before operation—Forty-one Admission diagnosis—Lobar pneumonia Type of pneumonia cases—? Anesthesia—Local Bacteriology of chest fluid—Streptococcus and staphylococcus Number of packings—Five Days of elevated temperature post-operative—Fourteen



FIG 16—Eugene F A case of postpneumonic empyema showing the shadow obscuring almost the entire right lung. April 23 1929. Patient was treated by thoracotomy and packing of the entire pleural cavity

FIG 17—Eugene F Condition May 6 1929 shows slight pleural thickening but no fluid in the pleural cavity which was clean. The large thoracotomy wound tended to close so rapidly that it was necessary to place a tube down to but not into the pleural cavity

Days in bed post-operative—Sixteen Days in hospital—Twenty Remarks—Discharged healed

CASE VIII—J H, colored, male, aged thirty-three years Days ill before operation—Twelve Admission diagnosis—Acute pleurisy Anesthesia—Local Bacteriology of chest fluid—Pneumococcus Number of packings—One Days of elevated temperature post-operative—Five Days in bed post-operative—Five Days in hospital post-operative—Thirteen Remarks—Pockets not broken down Drainage difficult Packing unsatisfactory unless pockets removed Discharged healed

CASE IX—H F, colored, male, aged forty-two years Days ill before operation—Twenty Admission diagnosis—Lobar pneumonia Type of pneumonia—IV Anesthesia—Local Bacteriology of chest fluid—Pneumococcus Number of packings—Five Days of elevated temperature post-operative—Twenty-one Days in bed post-operative—Twenty-two Days in hospital post-operative—Twenty-four Remarks—Discharged healed

CASE X—R K, colored, female, aged forty-two years Days ill before operation—Thirty-one Admission diagnosis—Pulmonary tuberculosis Anesthesia—Local Bacteriology of chest fluid—Pneumococcus Number of packings—Four Days of elevated temperature post-operative—Three Days in bed post-operative—Fifteen Days

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packings—Fourteen Days of elevated temperature post-operative—Eleven Days in bed post-operative—Fifteen Days in hospital post-operative—Sixty-five Remarks—Recovery slow Wound open at time of discharge Follow-up clinic reported closure in a few weeks

CASE XIX—O R, white, male, aged fourteen years Days ill before operation—



FIG 19



FIG 20

FIG 19—Alther H A postpneumonic empyema in an emaciated child treated by thoracotomy and picking of the entire pleural cavity with iodoform gauze. Although the picture demonstrates a shadow over the lower right lobe with the patient in the erect position, operation revealed pus throughout the entire pleural cavity. January 21, 1931.

FIG 20—Alther H Eighteen days after operation there was no pneumothorax, the wound was closed and granulating. The patient was cured. February 9, 1931.

Twenty-five Admission diagnosis—Lobar pneumonia Type of pneumonia—I Anesthesia—Gas oxygen Bacteriology of chest fluid—Pneumococcus Number of packings—Twenty-seven Days of elevated temperature post-operative—Twenty-nine Days in bed post-operative—Twenty-five Days in hospital post-operative—Seventy-



FIG 21



FIG 22

FIG 21—Bert P A postpneumonic empyema of the right pleura, multilocular in type. All septa were broken down and the entire pleural cavity packed tightly and frequently with iodoform gauze. Although the pleural cavity was kept clean a thick fibrinous exudate formed which necessitated decortication to allow for expansion of the lung which it held immobile. September 4, 1930.

FIG 22—Bert P Final result. There is no thickening of pleura, no pneumothorax, and the wound is firmly healed. January 13, 1931. The patient is cured.

one Remarks—End-result good Packed too many times Retards recovery and tends to prevent lung expansion

CASE XX—V H, colored, male, aged eighteen years Days ill before operation—? Admission diagnosis—Lobar pneumonia Type of pneumonia—? Anesthesia—

tion—Sixteen Admission diagnosis—Lobar pneumonia Type of pneumonia—Anæsthesia—Ether Bacteriology of chest fluid—Pneumococcus Number of packings—Three Days of elevated temperature post-operative—Eight Days in bed post-operative—Nine Remarks—Had two operations for two distinct pus cavities Results excellent

CASE XXX—E G, colored, female, aged six years Days ill before operation—Thirty Admission diagnosis—Lobar pneumonia Type of pneumonia—Anæsthesia—Spinal Bacteriology of chest fluid—No growth Number of packings—One Day of death post-operative—Same day Remarks—Death attributed to overdose of novocaine

CASE XXXI—J G, colored, male, aged two years Days ill before operation—Twenty-two Admission diagnosis—Lobar pneumonia Type of pneumonia—IV Anæsthesia—Ether Bacteriology of chest fluid—Pneumococcus Number of packings—? Day of death post-operative—Seventy-first day Remarks—Bronchial fistula Convalescence never satisfactory

CASE XXXII—P P, white, male, aged two years Days ill before operation—Fourteen Admission diagnosis—Lobar pneumonia Type of pneumonia—I Anæsthesia—Ether Bacteriology of chest fluid—Pneumococcus Number of packings—Eleven Days of elevated temperature post-operative—Sixteen Days in bed post-operative—Fifty-three Days in hospital post-operative—Sixty-five Remarks—Discharged healed

CASE XXXIII—R M, colored, male, aged two years Days ill before operation—Thirty-one Admission diagnosis—Lobar pneumonia Type of pneumonia—I Anæsthesia—Gas-oxygen Bacteriology of chest fluid—Pneumococcus Number of packings—Forty-four Days of elevated temperature post-operative—Five Days in bed post-operative—Eleven Days in hospital post-operative—One hundred and forty-one Remarks—Packed too many times End-result good

CASE XXXIV—R J, colored, male, aged thirty-five years Days ill before operation—Thirty-two Admission diagnosis—Lobar pneumonia Type of pneumonia—VII Anæsthesia—Local Bacteriology of chest fluid—Pneumococcus Number of packings—? Days of elevated temperature post-operative—Twenty-seven Days in bed post-operative—Thirty-six Days in hospital post-operative—One hundred and nine Remarks—Too many packings Wound unhealed on discharge, but now entirely healed

CASE XXXV—P T, colored, male, aged thirty-five years Days ill before operation—Fifteen Admission diagnosis—Lobar pneumonia Type of pneumonia—X and XVIII Anæsthesia—Ether Bacteriology of chest fluid—Pneumococcus Number of packings—? Days of elevated temperature post-operative—Twenty-four Days in bed post-operative—Twenty-seven Days in hospital post-operative—Seventy Remarks—Ruptured lung abscess present Recovery slow Condition good

*What Are the Objections to the Operation?*—In the beginning, four chronic sinuses resulted, due to the too tight packing and to invasion of uncontaminated pleura This has been eliminated it is believed, by the use of only one tight packing and by nondestruction of the adhesions In several cases it was observed that the pulse was accelerated by twenty or more beats per minute, by the use of the tight packing This was particularly true when the packing was applied with some pressure to the region of the base of the heart In each instance, release of the pressure of the packing allowed the heart to beat more slowly The most interesting patient in this connection was R J, who had an empyæma localized entirely on the left side In the X-ray picture it was impossible to differentiate the shadow of this empyæma from that of a pericardial effusion An anterior incision

adhesions. He depended upon aspiration to tide the patient over until the collection of pus was localized.

Doctor Flick felt that the bronchoscopic treatment of pulmonary abscess, in the hands of an expert, is of real value. Louis H. Clerf recently reported a brief summary of the results of treatment in a series of seventy-seven cases of pulmonary abscess following tonsillectomy. Thirty-eight of these patients were ultimately discharged as well after a course of bronchoscopic treatment. It is, of course, obvious that the earlier the treatment is instituted, the better the prospect for cure and that conservative treatment should not be continued for too long a period of time if a cure is not forthcoming.

In 1926, J. A. Miller and A. V. S. Lambert called attention to the fact that external drainage does not drain the pneumonic process about the central suppurating focus which is present during the acute phase of pulmonary abscess, and that with the establishment of a free opening, the effectiveness of coughing to empty these areas is greatly reduced. This had been the speaker's own experience and he was then packing pulmonary abscesses firmly with gauze in order to remedy this difficulty. At first he used iodoform, but gradually drifted to the use of plain gauze.

DR. GEORGE D. STEWART said he was satisfied that this treatment of empyæma as developed by Doctor Connors is founded on sound surgical principles. He agreed with Doctor Flick that it was not applicable or necessary to use such a radical procedure in all empyæma cases, it is frequently only necessary to take out a little bit of rib and follow this with drainage and symptomatic treatment.

stones from the common bile duct causing the obstruction was carried out with ease but in spite of every effort to control hepatic toxæmia including blood transfusions and injections of glucose both before and after operation the patient failed to recover. The corollary of this is that gall-stones should be removed before jaundice appears. It should be emphasized that if jaundice does occur, the patient should be placed immediately under a clinician's and surgeon's care to determine whether the obstruction is intrahepatic or extrahepatic and if the latter to determine the propitious time for operation, in order that the prolonged effects of biliary obstruction may not menace the patient's life.

The constituents of drainage from the biliary passages, after an operation, afford valuable information concerning the function of the liver. Last year, Greene, Fredrickson and I<sup>4</sup> <sup>13</sup> studied the composition of the bile following the relief of biliary obstruction in nine cases. These cases were equally divided into three groups in which the obstruction was due (1) to stone in the common bile-duct, (2) to carcinoma at the head of the pancreas, and (3) obstructive jaundice due to cholangitis, associated with biliary cirrhosis. The output of the bile pigment (bilirubin), of the bile acids, of the urea and of the chlorides was studied. The concentration of bile acids was regarded to be of considerable significance in that if the hepatic cells did not function properly, the bile acids were late in appearing and remained at a low level. The total amount of bile pigment however, in all three groups, remained almost constant with the exception that its concentration varied inversely with the volume of the bile, that is, the lesser the amount of the bile, the greater the amount of the bile pigments and *vice versa*. The concentration of urea in the bile varied directly with that in the blood. Ordinarily this pathway of elimination is not significant but in one case there was considerable loss of urea through the fistula.

The quantity of bile drained in the cases of stone in the common bile-duct averaged approximately 500 to 700 cubic centimetres in twenty-four hours. In contrast, in the cases of carcinoma of the pancreas producing obstruction, the approximate average output of bile in twenty-four hours was 1,300 cubic centimetres and on some occasions it was as much as 2,000 cubic centimetres. The significance of this tremendous loss of fluid must not be underestimated, especially since analysis of the bile showed that approximately ten times as much sodium chloride was lost from the tissues of the body through this biliary drainage as was lost in the cases in which the obstruction was due to stone. This is probably the reason that an external biliary fistula in such cases usually terminates the patient's life. Explanation for this large biliary output is better understood by a study of Counseller and McIndoe's<sup>2</sup> cellordin and corrosion specimens of the biliary passages. When a stone in the common bile-duct is the cause of the jaundice, there is associated infection in the common bile-duct, the hepatic bile-ducts and their branches within the liver. Such intrahepatic infection in the walls of these ducts probably prevents their dilatation. This may be noted in the change in the color of the common

duodenum in 1926 for the relief of a stricture of the lower end of the common bile-duct. The patient had been in bed for almost a year prior to operation. Subsequent to operation, although recovery was slow, the patient was able to return to part of her household duties within a few months. During the next year, improvement was slow, at times transient jaundice occurred, lasting a few days, without fever or pain. During the succeeding year these periods of jaundice became fewer and shorter in duration, and the next year she returned to the clinic for examination. She was found to be in good condition. There was approximately 1 milligram of bilirubin in the blood serum and there was no ascites or evidence of jaundice of the skin or sclera. She furthermore stated that she had enjoyed good health during the year.

Additional problems in the treatment of patients with cirrhosis of the liver have been the study and application of methods directed to the prevention of fatal intestinal hæmorrhages, usually from bleeding varices of the œsophagus. McIndoe, in his dissections of these varices and their tributaries, has shown that venous blood obstructed by a cirrhotic liver causes varices of the œsophagus due to the extensive collateral circulation between the left coronary vein lying in the gastrohepatic omentum along the lesser curvature of the stomach and the branches of the internal mammary vein. Rowntree proposed that ligation and division of the branches of the left coronary vein be done, hoping thus to reduce the amount of blood passing through the varices from the coronary veins to the internal mammary veins. This has been done in four cases<sup>8 9 14</sup> at the clinic, with temporary relief of the bleeding, in one case relief was obtained for more than a year. The procedure was combined with splenectomy in two cases and further hæmorrhage did not occur. It is too early to evaluate the effect of ligation of the coronary veins, too few cases have been observed to allow one to formulate an opinion. In two cases in which successful total gastrectomy was done recently for extensive carcinoma<sup>10 12</sup> excellent exposure of the lower end of the œsophagus was attained by the use of a left rectus incision and under spinal anaesthesia. The appearance of the lower end of the œsophagus in these cases leads me to believe that possibly the coronary veins have not been ligated high enough or near enough to the œsophageal varices. Ligation higher and nearer the œsophageal varices will be carried out in a properly selected case. Furthermore by the use of a minor procedure to thrombose these veins, consideration is being given to the use of small injections of glucose solution into the vein on the exterior surface of the lower end of the œsophagus, with the possibility of thus producing thrombosis of the varices in the intima.

The abnormal position of the liver often will produce a group of symptoms identical with those which have been recognized to be associated with shock, consisting of rapid pulse rate, low blood-pressure, increase in respiratory rate, and anæmic appearance of the skin<sup>11</sup>. Such a depression occurred following the anastomosis between the stump of a hepatic duct and an open-

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## TABLE

CASE I—Post mortem No 15, 1929 Aged sixty nine years male white Duration—? Time under Medical Care—Three weeks Clinical Features in Order of Appearance—None from tumor, ruptured peptic ulcer Findings—Severe anemia, peritonitis Clinical Diagnosis—Ruptured gastric ulcer Death—Bronchopneumonia Location—Attached to common hepatic duct Structure—Gross—Single solid Structure—Microscopic—Adenoma Secondary Effects—None Metastases—None Incidental findings—Peptic ulcer

CASE II—Post mortem No 830, 1930 Aged fifty years female, colored Duration—? Time under Medical Care—Two weeks Clinical features in Order of Appearance—None from tumor, cardiac decompensation Findings—Dependent edema Clinical Diagnosis—Hypertensive heart disease Death—Cardiac decompensation Location—Between cystic duct and liver Structure—Gross—Single, cystic Structure—Microscopic—Congenital cyst Secondary Effects—None Metastases—None Incidental Findings—Hypertrophy of heart, subacute glomerulonephritis

CASE III—Post mortem No 811 1930 Aged fifty nine years male white Duration—Fifteen years Time under Medical Care—Six days Clinical Features in Order of Appearance—None from tumor cardiac decompensation, gall stone colic Findings—Dependent edema Clinical Diagnosis—Hypertensive heart disease Death—Cardiac decompensation Location—Stump of cystic duct Structure—Gross—Polypoid Structure—Microscopic—Amputation neuroma Secondary Effects—None Metastases—None Incidental Findings—Hypertrophy of heart, cholelithiasis, chronic cholangitis

CASE IV—Post mortem No 688 1929 Aged sixty years male white Duration—Four and one half months Time under Medical Care—Three weeks Clinical Features in Order of Appearance—(1) Slight chronic ulcer distress, (2) obstructive jaundice, (3) diarrhoea (4) cachexia Findings—Gall bladder palpable liver palpable Clinical Diagnosis—Carcinoma of head of pancreas or gall bladder Death—Cholemia, lobar pneumonia Location—Common bile duct lower end Structure—Gross—Scirrhus localized Structure—Microscopic—Adenocarcinoma Secondary Effects—Gall bladder distended, liver enlarged, pancreatic duct obstruction Metastases—Peribiliary and peripancreatic lymph nodes, liver pancreas infiltrated Incidental Findings—Lobar pneumonia, chronic peptic duodenal ulcer

CASE V—Post mortem No 75 1929 Aged sixty eight years male, white Duration—Three months Time under Medical Care—Three weeks Clinical Features in Order of Appearance—(1) Cough (2) cachexia (3) rectal obstruction, (4) inguinal lymphadenopathy, biopsy (5) obstructive jaundice late Findings—Melena Clinical Diagnosis—Carcinoma of rectum Death—Cholemia bronchopneumonia Location—Common bile duct, lower end extending to junction Structure—Gross—Scirrhus infiltrating Structure—Microscopic—Scirrhus goblet cells Secondary Effects—Gall bladder distended liver normal, ascites Metastases—Peribiliary, peripancreatic and periaortic lymph nodes mesentery omentum peritoneum inguinal lymph nodes wall of left ureter wall of rectum liver lungs, pleura, adrenals pancreas Incidental Findings—Bronchopneumonia left hydronephrosis

CASE VI—Post mortem No 640 1930 Aged seventy two years male white Duration—Seven months Time under Medical Care—Five weeks Clinical Features in Order of Appearance—(1) Diabetes mellitus, (2) vague dyspeptic symptoms (3) obstructive jaundice (4) severe abdominal pain (5) cachexia Findings—Glycosuria Clinical Diagnosis—Carcinoma of head of pancreas Death—Cholemia Location—Common bile duct middle extending to junction Structure—Gross—Scirrhus infiltrating Structure—Microscopic—Adenocarcinoma goblet cells fibrosis Secondary Effects—Gall bladder distended ascites liver enlarged pancreatic duct obstruction Metastases—Local metastases to cystic duct peribiliary lymph nodes, liver left adrenal pancreas infiltrated Incidental Findings—Atrophy of pancreas

CASE VII—Post mortem No 759 1928 Aged seventy two years male white Duration—Four and one half months Time under Medical Care—Two weeks Clinical Features in Order of Appearance—(1) Severe acute, atypical ulcer distress (2) obstructive jaundice (3) cachexia Findings—Gall bladder palpable liver palpable Clinical Diagnosis—Carcinoma of stomach or head of pancreas Death—Cholemia Location—Common bile duct middle extending to junction Structure—Gross—Polypoid infiltrating Structure—Microscopic—Adenocarcinoma goblet cells, solid alveoli Secondary Effects—Gall bladder distended, liver normal size ascites Metastases—Peribiliary peripancreatic and periaortic lymph nodes with perforation into cisterna chyli mesenteric lymph nodes Virchow gland liver right adrenal Incidental Findings—Cholecystic with empyema of gall bladder stones in gall bladder and common duct, duodenitis

CASE VIII—Post mortem No 434 1928 Aged forty seven years female white Duration—Three and one half months Time under Medical Care—Two weeks Clinical Features in Order of Appearance—(1) Acute catarrhal jaundice (2) obstructive jaundice with one early remission (3) severe secondary anemia, (4) pseudobiliary colic, (5) cachexia Findings—Gall bladder palpable, liver palpable melena severe Clinical Diagnosis—Carcinoma of stomach or head of pancreas or gall bladder Death—Cholemia anemia Location—Common bile duct, lower end Structure—Gross—Scirrhus localized Structure—Microscopic—Adenocarcinoma Secondary Effects—Gall bladder distended, liver normal size pancreatic duct obstruction Metastases—Peribiliary lymph nodes pancreas infiltrated duodenum infiltrated Incidental findings—Bronchopneumonia acute secondary carcinomatous ulceration of duodenum

CASE IX—Post mortem No 104 1931 Aged eighty six years female white Duration—? Time under Medical Care—One day Clinical Features in Order of Appearance—Admitted moribund no history (1) obstructive jaundice (2) cachexia Clinical Diagnosis—Carcinoma of head of pancreas Death—Cholemia Location—Common bile duct lower end Structure—Gross—Scirrhus localized Structure—Microscopic—Papillary adenocarcinoma goblet Secondary Effects—Gall bladder distended liver normal size Metastases—Lung Incidental Findings—Chronic peptic duodenal ulcer

CASE X—Post mortem No 685 1930 Aged fifty three years male colored Duration—Two and one half months Time under Medical Care—Two months Clinical Features in Order of Appearance—(1) Severe acute ulcer distress, (2) obstructive jaundice late (3) severe secondary



lymph-node\* There was no stone or other associated irritant The mass was solid, and was attached to the wall of the common hepatic duct, causing, however, no compression of it It was composed of almost solid alveoli of regular cells and goblet cells were absent The patient had died of a perforated gastric ulcer and the node was examined microscopically only because the question was raised of its being a metastasis from a possible malignant transformation of the peptic ulcer Such malignancy was, however, histologically excluded (Fig 1)

Cysts of the biliary tract are of three main types They may be saccular dilatations due to some local obstruction at the mouth of a parietal sacculus



FIG 1—Benign adenoma of the common hepatic duct Composed of solid alveoli of regular cells separated by trabeculae of fibrous tissue No goblet cells Note the two small bile duct like structures near the centre Low power Magn 70 Hemotoxylin and eosin

Adenomas may become cystic, either by mucoid transformation, or by degenerative changes from circulatory disturbance Such cystic adenomas are multilocular, and between the loculi, separated muscle fibres of the bile-duct wall are often found (Alexander<sup>4</sup>) Finally, there may be congenital cysts These are unilocular, and no muscle fibres are ever found in their wall They represent simple malformations, dilatations of an aberrant bile-ductule isolated without an accompanying acinus of hepatic cells

\* For the material of this case I am indebted to the Department of Pathology of the University of Illinois Research Hospital

hepatic cholangitis. Hanging like a polyp into the dilated stump of the cystic duct, there was a caterpillar-shaped histologically typical amputation neuroma (Figs 2 and 3).

It was 15 millimetres long and 5 millimetres in transverse diameter, quite firm, and covered by a light yellow, smooth membrane of mucosa. The bulk of the polyp was composed of two structures which interlaced with each other in various directions. There were bundles of fibres to which were attached long, band-shaped, finely granular nuclei. These fibres showed little affinity to the hæmatoxylin-eosin, Van Gieson or Mallory phosphotungstic acid stain. With the latter stain they appeared very light purple. Between these fibres there was a moderate number of small blood-vessels.



FIG. 3.—High power view of amputation neuroma. Mallory phosphotungstic acid hæmatoxylin stain. Bundles of nerve fibrils (more lightly stained) separated by strands of darkly stained fibrous tissue. Leitz apochromat 16 periplanar 6.

The second type of structure was formed by bundles of connective tissue stained reddish-brown after Van Gieson and bright purple after Mallory stain. Nerve bundles in the wall of the cystic duct were found extending into the polyp where they fused with the bundles of light-stained fibrils. (Dr R. H. Jaffe.)

The cystic-duct stone and the infection may have been factors favoring the formation of the neuroma, but it, itself, had caused no obstruction or any other symptoms. The patient did complain of recent biliary colics but these could be accounted for by the stones. He died under the clinical picture of cardiac decompensation. Husseinoff<sup>10</sup> reports the only other case which I could find in the literature, of amputation neuroma of the cystic duct. They are much less infrequent in the appendix.

variable and often so noncommittal that an early diagnosis is extremely difficult. For some time, also, the symptoms are fairly mild, so that patients do not even seek medical attention. The cases here recorded were under known medical supervision for only two weeks to two months before death, with an average duration of alarming symptoms of only one month. Thus, though these tumors announce their presence promptly enough, they are actually available for therapeutic approach for only a very short period of time.

Even in this short period of time, the clinical picture is rarely simple and characteristic. The clinical syndrome usually described is composed of an insidious onset with the first symptom a painless, steadily, relentlessly progressive obstructive jaundice, with rapid loss of weight and strength until death occurs in simple asthenic cholæmia. Such a picture is, in fact, rare. Much more often there are variations and complications which long hamper the correct diagnosis.

Jaundice is held to be usually the first and the most reliable symptom (see Musser<sup>15</sup> and Renshaw<sup>16</sup>). In this material, however, jaundice was not the first symptom. Case VI was admitted as a simple, mild, senile, arteriosclerotic diabetes mellitus. While in the hospital, under fairly well maintained diabetic control, he incidentally developed a rapidly and steadily progressive obstructive jaundice which in one month led to death. Case XV began with an ascites which so dominated the clinical picture as to suggest a preliminary diagnosis of portal cirrhosis or tuberculous peritonitis. Jaundice first appeared only three weeks after the onset.

Case V entered with the complaints of pain in the back, cough, weakness and loss of weight. Rectal examination revealed a firm mass bulging into the rectal lumen. The right inguinal lymph-nodes became enlarged, and biopsy of one of them revealed a metastatic colloid carcinoma. Only nine days before death from a bronchopneumonia, a slight icterus appeared. The clinical diagnosis was carcinoma of the rectum with metastases to the liver. At autopsy, a carcinoma of the common bile-duct was found, which had announced itself by rectal, inguinal and lung metastases long before it had produced jaundice. Cases VIII and XIV presented an acute onset of gastrointestinal and slight febrile symptoms, followed shortly by the onset of jaundice. They simulated at first the so-called "acute catarrhal jaundice." Only the persistence and progress of the jaundice finally established the correct diagnosis.

Several cases gave a history of chronic dyspeptic symptoms preceding the onset of the obstructive jaundice for a long time. In four (Cases VI, XI, XII and XV), these were mild and rather vague, characteristic of neither ulcer nor gall-bladder pathology. In others, however, they were definitely referable to an associated peptic ulcer. Case IV had complained of mild post-prandial pain in the left upper quadrant for years. It was readily relieved by food or soda. In Case X, ulcer symptoms dominated the clinical picture. It began with a vague ulcer distress which soon grew worse, ceased to yield to soda or diet, and finally drove the patient to seek medical aid.

Puritus accompanied the jaundice in two cases (XIII and XIV) and followed its onset in a third (XI). Bilirubinemia, bilirubinuria and acholic stools were constant accompaniments. Diarrhoea was marked in only one case (IV). Melæna appeared in seven cases and in each was a confusing finding. In three it was due to massive bleeding from duodenal ulceration, in Case X an incidental peptic ulcer, in Case VIII a secondary carcinomatous ulceration, in Case XIV a decubitus ulcer overlying metastatic lymph-nodes. In Case XII massive gastro-intestinal bleeding without any definite lesion occurred as part of the hæmorrhagic diathesis of jaundice. In these four blood appeared in the stools in large quantities, and severe secondary anæmia outraced the cholæmia in causing death. Hæmorrhagic diathesis led to slight or moderate melenæ in Cases V, XI and XIII and in each aroused the suspicion of carcinoma of the stomach or large bowel.

Severe cachexia was prominent in all cases except XI. The gall-bladder was palpable clinically in only six of the twelve cases. Courvoisier's law thus held in only 50 per cent (Vincent<sup>23</sup>). The liver was palpably enlarged in four of these six cases. It was palpable also in Case XII. Here a carcinoma of the common hepatic duct had caused hepatic enlargement without giving gall-bladder enlargement. Ascites was found in three cases. The spleen was never palpable.

The case of carcinoma of the ampulla of Vater (XI), followed much the same clinical course as the others. The accepted differential features, such as the greater tendency to suppurative cholangitis, to necrosis of the tumor with melæna and intermission of jaundice to more marked diarrhoea and to more marked pancreatic-duct obstruction were not present in this case. There was no steatorrhoea or azotorrhoea, or glycosuria. The pancreas and its duct were only slightly involved. Chiray<sup>24</sup> and Carnot<sup>25</sup> have done considerable work with duodenal aspiration in an effort to distinguish biliary from pancreatic carcinomas. The method readily distinguishes biliary or pancreatic or common obstruction, but the results are ambiguous. For carcinoma of the common bile-duct may infiltrate the head of the pancreas and occlude the latter's duct even before jaundice occurs. Carcinoma of the head of the pancreas may, on the other hand (as it did in a recent case in our laboratory, Post-Mortem No. 64, 1931) compress the bile-ducts to produce jaundice, while leaving the pancreatic duct still free. Stone may similarly occlude the pancreatic or biliary duct or both, and give almost the same "tubage" findings as carcinoma.

The early diagnosis of carcinoma of the extrahepatic bile-ducts, even an early diagnosis, in these cases, of malignant obstructive jaundice, is no easy task. The jaundice is often only a clinical afterthought. Even when it does appear, the symptomatology is so variable, so non-committal, and so often burdened with incidental complications that only a vague tentative diagnosis can be made. The most that can be expected in these cases is a diagnosis sufficiently definite to warrant early exploratory laparotomy. Even this is not always possible.

prising, therefore, that it is often involved, but this involvement is secondary. More accurate anatomic localization of the tumors will reduce the number listed as junctional, or "confluence," or "carrefour" tumors (Brocq<sup>27</sup> and Pliveric<sup>28</sup>).

Tumors in the region of the papilla of Vater may arise from the bile-duct, from the pancreatic duct, from the mucosa of the ampulla proper (the biliary-pancreatic pylorus of Hanot<sup>29</sup>), from the head of the pancreas, or from the duodenal mucosa or Brunner's glands. The parts are so small that it is often impossible to distinguish the exact site of origin and the tumors are classified simply as carcinomas of the papilla of Vater. Ampulla carcinomas are usually cylindrical-celled adeno-carcinomas, the pancreatic ones are usually small, round-celled carcinomas. The adeno-carcinoma in Case XI was small enough to permit accurate localization from the ampulla with slight extension into the lower end of the common bile-duct.

There was no striking difference between the scirrhus and polypoid tumors in their microscopic structure. Most of the tumors were composed of irregular glands lined by columnar epithelium with cuboidal to cylindrical cells, and anaplastic nuclei (eight cases). The glands were separated by a small to moderate amount of fibrous tissue. The lining cells were sometimes piled up into several layers. This tendency to form solid alveoli was slightly more marked in the polypoid forms, the tendency to fibrosis was slightly more marked in the scirrhus. There was, in addition, one almost solid alveolar carcinoma which was grossly scirrhus, and one pure carcinoma solidum which was grossly polypoid. There was one microscopically scirrhus carcinoma with a large amount of fibrous tissue between the single cancer cells of the primary tumors. In the metastases, however, there was much less fibrosis and more anaplasia. There was finally one case of papillary adenocarcinoma. Squamous-cell carcinomas of the extrahepatic bile-ducts have also been reported (Fehr<sup>30</sup> and Cabot<sup>31</sup>) but none were found here.

A striking feature of the microscopic sections, in both the scirrhus and polypoid forms, was the tendency to colloid degeneration (six cases). The tumors resembled those of intestinal epithelium with numerous goblet cells and the production of much mucoid material (Fig. 4). This was even more marked in the metastases than in the primary tumors. Pseudomyxoma peritonei is well known to originate from bile-duct carcinomas.

Normally, there are no goblet cells in the lining epithelium of the bile-ducts. It was therefore suggested that the simple adeno-carcinomas arose from the surface epithelium or from the parietal sacculi, while the colloid carcinomas arose from the mucous glands which open into the sacculi. There is no definite proof for this except the vague resemblance between goblet cells of mucous glands and vacuolated carcinoma cells. Under any chronic irritation, goblet cells appear in the bile-duct lining. The bile-ducts are intestinal evaginations. The parietal sacculi and associated glands represent only branched diverticula of the original intestinal outpouching (see Keibel and Mall<sup>32</sup>). The origination under irritation of colloid carcinomas is a

severe cases, a centro-acinar icteric necrosis (see Fueter<sup>37</sup>) The liver is enlarged by distention or metastases unless a cirrhotic or atrophic degeneration has reduced it It was found definitely enlarged in four cases, of about normal size in five cases and decreased in size in three cases Three times it was palpable clinically, yet normal in size, twice it was enlarged, but not palpable

The pancreas was rarely much disturbed The pancreatic duct may be directly occluded at its orifice, or be constricted by diffuse carcinomatous infiltration of the head of the pancreas One-third of the bile-duct carcinomas arise in the lower part of the ductus choledochus close to the ampulla But pancreatic-duct occlusion is not usual, for the duct does not always enter the duodenum in common with the ductus choledochus (Springer<sup>38</sup>) It may enter at quite some distance from it (as it did in Case IX), with or without a papilla of its own Even if the Wirsungian duct is occluded, the accessory duct of Santorini is actually the main duct in 12 per cent of cases and can substitute adequately for the main duct in draining the pancreatic external secretion, in another 54 per cent (Keen<sup>39</sup>) The pancreatic duct was partly obstructed in four cases but no marked deficiency in pancreatic external secretion followed

Nor did it in any case seriously disturb the pancreatic internal secretion Indeed, duct obstruction leads to island regeneration (Opie<sup>40</sup>) unless this is prevented, as it was in Case VI, by a preceding arteriosclerosis (Dr R H Jaffe) There was a chronic interstitial pancreatitis in Case VIII, in Case IV the pancreas was reduced to a fibrotic shell, but glycosuria did not follow

Ascites was present in six cases, from carcinomatosis of the peritoneum in Cases V and XV, from compression of the portal vein by enlarged peribiliary lymph-nodes in Cases VII and XIV, from hepatic metastases alone in Case VI, from suppurative pyelophlebitis adjacent to hepatic metastases in Case XIII The ascites was massive only in Case XV

In Cases VII and XIII a cholecystitis was present, with a stone at the neck of the gall-bladder and a chronic empyema In Case VII the cholecystitis was perfectly symptomless Here there were stones also in the ductus choledochus distal to the tumor In Case X there was a chronic ulcerative cholecystitis, but no stones In our material, stone was associated with carcinoma of the bile-ducts in only 16 per cent This is usually given as 30 per cent, in striking contrast with carcinoma of the gall-bladder, in which stone is present in fully 80 per cent (Miller<sup>41</sup>)

The frequent association of stones with primary carcinomas of the gall-bladder and their absence in secondary carcinomas led to the assumption that they were very important in the etiology of carcinoma of the gall-bladder This was used as an argument in favor of cholecystectomy for stone, rather than cholecystotomy White<sup>42</sup> declared that 20 per cent of all persons with gall-stones ultimately developed biliary-tract carcinomas Lotzin,<sup>43</sup> however, emphasized that this was exaggerated, and, further, that it was not the stone

ing failure in these cases now is not the operative maneuver but the hæmorrhage, shock and infection to which the jaundiced patient is so markedly susceptible and to accidental complications such as those described in our cases (see Stanton<sup>49</sup>)

The supposition that these tumors announced their presence by striking and characteristic symptoms long before they metastasized, and could therefore be approached with good prospects of permanent cure, had markedly stimulated the perfection of technic and of pre- and post-operative manage-

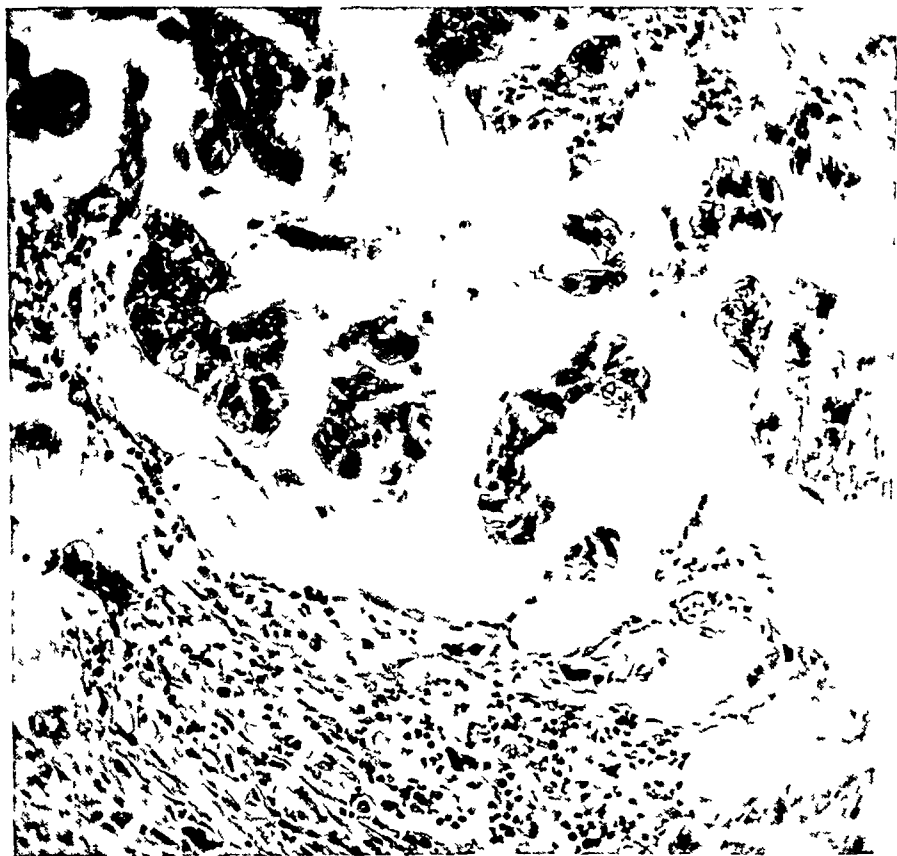


FIG 5—Colloid carcinoma metastasis in marginal sinus of inguinal lymph node. Note papillary infolding. Primary tumor in common bile duct. Leitz apochromat 8 mm. periplanar 6. Hæmatoxylin and eosin.

ment. It was usually considered that metastases occur in only 20 per cent of bile-duct carcinoma. But even with successfully effected radical resections, permanent cures have been very few. The hopefulness of radical resection was a surgical mirage (Thevenod<sup>50</sup>).

These tumors, according to our material, are not less prone than others to metastasize. They do not declare themselves forcibly and unequivocally long before they metastasize. The clinical course, especially that part of it which is severe enough to demand medical attention, is brief. In this short time, metastases are already widespread. Metastases were present in all our twelve cases except one.

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# HÆMATOLOGIC STUDIES AS A BASIS FOR DETERMINING THE RISK OF POST-OPERATIVE HÆMORRHAGE IN JAUNDICE PATIENTS\*

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ONE of the most serious problems in operative surgery is the deeply jaundiced patient. It is generally agreed that these patients are very poor operative risks. In many instances death is caused by pneumonia or post-operative infection, due to poor resistance.

However, hæmorrhage is the most frequent complication and at the same time the most important factor in post-operative mortality. Broadly speaking, the risks of a post-operative hæmorrhage depend on two factors: (1) the degree, and (2) the duration of the jaundice. Each one of these two factors may cause post-operative hæmorrhage. For instance, a moderate jaundice of long duration or a very deep jaundice of short duration may be equally potent. When both factors are combined, any operative interference presents a most serious problem for the surgeon.

Furthermore, we cannot, before the operation, definitely predict whether a jaundiced patient will bleed. It is a well-known fact that a patient with deep jaundice of long duration may not bleed after the operation, whereas another patient suffering from a moderate jaundice of short duration may succumb to post-operative hæmorrhage.

It would be of the utmost importance if our laboratory investigation would enable us to segregate the bad risks from those who are apt to make an uninterrupted post-operative recovery. It is generally conceded that the pre-operative determination of the clotting time is without any practical value. Normal clotting time is no safeguard against post-operative bleeding. Even after the hæmorrhage has started, the clotting time may still be normal. In other cases, the clotting time may be lengthened considerably, yet the patient with a deep jaundice of many months' duration may make a smooth post-operative recovery.

Another test, namely, the icteric index, is of no practical value in the subject under discussion. As stated above, patients suffering from deep jaundice of long duration may make a smooth recovery, even after major operations. The icteric index is simply a numerical indicator of the degree of jaundice. It has been known for many years that large amounts of bile acids can be present in the blood for months, and even years, without causing any symptoms of toxicity or blood dyscrasia. As Wangensteen has stated

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\*Read before the Joint Meeting of the New York Surgical Society and the Philadelphia Academy of Surgery, February 11, 1931.

## RICHARD LEWISOHN

Five cubic centimetres of this plasma are put into the tubes

To first tube, add 3 cubic centimetres normal filtered plasma

To second tube, add 2 cubic centimetres normal filtered plasma

To third tube, add 3 cubic centimetres of filtered plasma to be tested

To fourth tube, add 2 cubic centimetres of filtered plasma to be tested

All tubes are equalized in amount by addition of 0.9 per cent NaCl. Mixtures are allowed to remain in contact fifteen minutes at 37.5° C. Plasma is recalcified by addition of 0.5 per cent CaCl<sub>2</sub> · 6 H<sub>2</sub>O, the number of drops which are added having been determined by the general coagulability test. The clotting time is observed at 37.5° C.

Determinations of clotting factors were performed in sixteen cases of jaundice. Some cases were nonsurgical, a few patients refused operation and others were cases of light jaundice with normal figure. They do not belong to the group under discussion.

I wish to report here very briefly results of these studies in seven cases. All these patients suffered from deep jaundice of long standing. Their sclerae were deeply yellow, assuming in some instances a greenish tinge. Stools were completely acholic. The urine was dark brown and full of bile. In other words, they presented intense jaundice and represented the worst forms of operative risk.

CASE I No 320186—M G, female, aged sixty-two, admitted November 10, 1930, discharged December 21, 1930. Four weeks' history of pain in the right upper quadrant. Complete block of common duct for three days. Icteric index, 40. Clotting factors: prothrombin, 11, fibrinogen, 1.04 per cent, antithrombin, 1.0, index, 1.1. Pre-operative prognosis in reference to post-operative hemorrhage: "Clotting factors normal. Prognosis good." This patient received liver-extract as pre-operative preparation. It seemed to me that liver-extract might improve the post-operative course of the jaundiced patient. Furthermore, I have noticed in two cases that moderate post-operative bleeding stopped after the use of liver-extract. Clotting factors before operation were (November 24th): prothrombin, 0.91, fibrinogen, 1.12 per cent, antithrombin, 1.25, index, 0.8. Pre-operative prognosis in reference to post-operative hemorrhage: "Good." Operation (November 24th) revealed one very large stone in the common duct. Patient made a good recovery.

CASE II No 319994—M E, female, aged forty, admitted November 3, 1930, died November 17, 1930. Deep jaundice for six weeks. Stools completely acholic. Mass in right upper abdomen. Temperature normal. Bleeding time, three minutes, clotting time, seven minutes. Clotting factors: prothrombin, 0.6, fibrinogen, 0.64 per cent, antithrombin, 1.22, index, 0.3. Pre-operative prognosis in reference to post-operative hemorrhage: "Index is too low. Patient is apt to bleed." Exploratory laparotomy revealed a carcinoma of the pancreas with metastases in the liver. Post-operative course: Patient appeared in good condition for two days. On the third day a large hæmatoma with continuous oozing from the incision occurred. Patient was probably bleeding internally, too, as the pulse became very small and rapid. She died on the fourth day following the operation. No post-mortem examination. Undoubtedly, the bleeding played an important role in hastening the fatal outcome.

CASE III No 319809—R E, female, admitted October 28, 1930, discharged November 30, 1930. Very deep jaundice for one month without fever. Bleeding time, three minutes, coagulation time, five minutes. Icteric index, 175, sedimentation time, 30 minutes. Clotting factors: prothrombin, 1.0, fibrinogen, 0.94 per cent, antithrombin, 1.03, index, 1.0. Pre-operative prognosis in reference to post-operative hemorrhage: "Patient presents normal figures. She is not apt to bleed following the operation."

present" Operation (January 29) Choledochotomy for stone Gall-bladder small, without stones, was left *in situ* The common-duct stone was removed through a small incision into the duct Drainage of the duct by a tube Patient began to ooze moderately through the abdominal incision on February 2 On the next day biliary drainage contained a large amount of blood Another transfusion was given on February 3 The tube was removed on February 4, in order to prevent clot formation in the common duct February 4 icteric index, 110 Another test for clotting factors (February 4) showed the following figures Prothrombin, 066, fibrinogen, 13 per cent, antithrombin, 125, index, 07 "Tests show bleeding tendency Prothrombin very low" The sedimentation test was repeated on February 4 It had fallen from seventy to twenty minutes Patient's condition became gradually worse He died February 9 Postmortem examination showed the common duct free, without stones or blood clot Hematoma and localized peritonitis in the right upper quadrant Cause of death cholæmia and localized peritonitis

TABLE

*Review of Clotting Factors in Seven Cases of Jaundice*

CASE I—November, 1930—Marked jaundice for three weeks, icteric index, 40, large stone in common duct Prothrombin, 11, fibrinogen, 104 per cent, antithrombin, 10, index, 11 Prognosis as to post-operative hæmorrhage—good Operation—Choledochotomy for stone Result—Well

CASE II—November, 1930—Deep jaundice for six weeks, carcinoma of the pancreas with liver metastases Prothrombin, 06, fibrinogen, 064 per cent, antithrombin, 122, index, 03 Prognosis as to post-operative hæmorrhage—Bad Operation—Exploratory laparotomy Result—Died of hæmorrhage No postmortem examination

CASE III—November, 1930—Deep jaundice for one month, icteric index, 175, common-duct stones Prothrombin, 10, fibrinogen, 094 per cent, antithrombin, 103, index 10 Prognosis as to post-operative hæmorrhage—good Operation—Choledochotomy for stones Result—Well

CASE IV—November, 1930—Deep jaundice for two months, icteric index, 180, carcinoma of the pancreas Prothrombin, 066, fibrinogen, 094 per cent, antithrombin, 118, index, 05 Prognosis as to post-operative hæmorrhage—bad Operation—None Result—Died of cholæmia and post-operative hæmorrhage No postmortem examination

CASE V—November, 1930—Deep jaundice for four months, cholelithiasis and common-duct stone Prothrombin, 081, fibrinogen, 111, index, 08 Prognosis as to post-operative hæmorrhage—good Operation—Cholecystectomy and choledochotomy for stones Result—Well

CASE VI—January, 1931—Deep jaundice with fever and chills for two weeks, two previous attacks, icteric index, 140, carcinoma of the gall-bladder with metastases in the liver Prothrombin, 064 before transfusion—078 after transfusion, fibrinogen, 13 per cent before transfusion—13 per cent after transfusion, antithrombin, 133 before transfusion—118 after transfusion, index, 06 before transfusion—09 after transfusion Prognosis as to post-operative hæmorrhage—bad Index improved after transfusion Impossible to say how long effect of transfusion will last Still considered bad risk Operation—Exploratory laparotomy Result—Died of hæmorrhage, post-mortem examination

CASE VII—January, 1931—Marked jaundice for ten weeks, icteric index, 40, February 5 icteric index, 110, stone in common-duct, choledochotomy Prothrombin January 27, 081, January 29, 088, after transfusion February 4, 066 Fibrinogen January 27, 094 per cent, January 29 094 per cent, February 4, 13 per cent Antithrombin January 27, 111, January 29, 103, February 4, 125 Index January 27, 07, January 29, 08, February 4, 07 Prognosis as to post-operative hæmorrhage—January 27, doubtful, January 29 good, February 4, bad Operation—January 29,

in the hope that others will try the tests. Then apparent correctness in the seven cases reported herewith possibly may be pure coincidence.

Clotting-factor determinations also may be of importance in determining the value of different procedures which are used more or less empirically in the pre-operative preparation of this group of patients. Intravenous or intrarectal injection of glucose solution, blood transfusion, intravenous medication of calcium chloride, parathormone, high carbohydrate diet, *etc*—they all have been used for a number of years in the attempt to improve the operative risk of these patients. No unanimity exists as to their value. For instance, Walters advocates calcium chloride for the reduction of prolonged coagulation time in the jaundiced patient. On the other hand, Ravdin, Riegel and Morrisson, in a very careful experimental study read at the joint session of these societies in 1930, concluded that administration of glucose caused shortening of the coagulation time, whereas calcium was ineffective in their experiments. If we could find a reliable hæmatologic test, such test could settle the value of these different methods of pre-operative preparation of the patient. Instead of relying on general impressions, we might be able to establish definitely the value of certain forms of treatment and discard others which are in use at present.

Furthermore, such tests may be important in another direction. When dealing with deep jaundice due to a common-duct stone many surgeons prefer simply to remove the obstructing calculus and to defer cholecystectomy to some later date. They are afraid that uncontrollable hæmorrhage may follow the dissection of the gall-bladder from the liver-bed. Undoubtedly it would be preferable to deal with the gall-bladder at the time of the primary operation, if we would know which cases are apt to bleed after the operation. As stated above, the degree and duration of the jaundice is not a definite indication. It is possible that pre-operative prothrombin and anti-thrombin determination may offer a valuable clue in this direction.

I beg to thank Dr. F. W. Bancroft and his staff for their most generous cooperation.

Since the presentation of this series eight additional cases have shown substantially the same results.

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DISCUSSION.—DR. F. S. RAVDIN remarked that the statement made by Doctor Lewisohn that hæmorrhage is the most frequent complication in

## MESENTERIC VASCULAR OCCLUSION

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MESENTERIC vascular occlusion, which in its acute form is one of the most baffling conditions with which a surgeon has to deal, was first described by Triedman in 1843. Virchow in 1847 described the pathology and Elliott in 1895 performed the first successful operation for this condition. In 1904 Jackson, Quinby, and Porter<sup>55</sup> reported a 92 per cent mortality in twenty-seven collected cases. Trotter<sup>60</sup> in 1914 reported that only 4 per cent of three hundred and sixty-six cases were correctly diagnosed. The operative mortality in this group was 63.8 per cent. Klein<sup>59</sup> in 1921 stated that there was record of only twenty-four successful operations in about five hundred cases. This background and comment on a case in my own experience has stimulated an analysis of the literature of the past ten years to gather information which might shed some light on earlier diagnosis or better management of the disease.

It soon became apparent that a knowledge of the etiology was necessary to attract attention to the possibility of the disease and a knowledge of the pathology in order that the condition would not pass unrecognized at operation. Therefore, a summary of the etiology and of the pathology as found at operation would not be amiss in this paper.

Accurate statistics are not available to determine the frequency of the disease because many cases pass unrecognized. Ten per cent in this series were overlooked at operation. Sheehan<sup>9</sup> states that at the Massachusetts General Hospital there were only thirteen cases in approximately 48,000 surgical admissions, and Ross reports only two cases in 30,000 admissions at the Lankenau Hospital. Loop<sup>28</sup> encountered nine cases in three years, Johnson<sup>56</sup> six cases in five years, and Watson<sup>57</sup> eight cases in one year.

The disease may occur at any age. The youngest patient in this series was four months<sup>31</sup>. The oldest was seventy-nine years of age. Bruns<sup>5</sup> reported one instance in a child eleven years old, and Frank<sup>17</sup> reported three cases in which the ages were eight, ten, and twelve years.

In the majority of instances there is some disease of the circulatory system as endocarditis, arteriosclerosis, atheroma, aneurism, phlebitis, or stasis of the portal system. There may be a history of trauma or of hernia but at times there may be no demonstrable etiological factor. In this series there were three patients with polycythæmia, and one with hæmophilia. Seven cases followed appendicitis operations, and two were associated with acute appendicitis.

The results of obstruction of the mesenteric vessels vary. Rarely, the occlusion may be complete without any abdominal symptoms or demonstrable changes in the intestine as in two of Brady's<sup>4</sup> and one of Trotter's<sup>60</sup> cases. Occasionally, the blood supply to the parts may be sufficient for life but not

veins Free fluid is usually present in large amounts and varies in color from transparent amber to bloody The fluid is odorless and usually contains no coagulated lymph

In dealing with the symptoms leading toward a diagnosis, one is beset with considerable difficulties owing to the diverse forms under which the disease appears In the majority of instances it is the final scene of a preceding protracted disease and is ushered in suddenly, without warning The following symptoms occurred most frequently

Pain was present in 100 per cent of the cases where any intestinal changes occurred It was usually severe from the onset, and constant with exacerbations It usually originated around the umbilicus and then became general A peculiar phenomenon which sometimes occurred was cessation of the pain soon after the onset only to recur a few hours or days later, the other symptoms meanwhile continuing unabated Cramp-like pains in the vessels of the leg were noted in three cases

Vomiting was stated to be present in 55 per cent and absent in 10 per cent of this series It occurred soon after the onset of the pain and was repeated Rarely was it present only at the onset, or only after the disease had existed several hours

Nausea was definitely stated to be present in only 20 per cent of the cases

Blood in the stools was reported in 14 per cent In three of these cases melæna did not occur during the first day In one instance it did not appear until the twelfth day

Diarrhœa was mentioned in 10 per cent

Tenderness was reported as present in 55 per cent and as absent in 8 per cent of the cases It varied in degree from just perceptible to very acute

Rigidity was listed as present in 16 per cent and as absent in 15 per cent Board-like muscular tension was not common

Distention was present at some time in 45 per cent

The temperatures reported ranged between 96° and 101° F In the twenty-six cases in which the duration of the disease was twenty-four hours or less the temperature was reported twelve times In eight of these it was below 98.6° F

The pulse was reported in thirty-nine instances It was normal or slow in fourteen If the pulse was not rapid at the onset, it usually became so in a short time In one instance the pulse was only sixty-eight seven days after the onset of acute symptoms

The leucocyte count was reported in twenty-three instances In all but three the count was above 18,000 The lowest report was 10,000 and the highest was 45,000 The increase is rapid and occurs very soon after the onset of pain

Urine chemistry was given in three instances In two of these indican was reported as four plus, and in the other urobilin was reported as three plus

No blood chemistry findings before operation were recorded

No X-ray examinations to determine presence of gas were recorded

cedures when gangrene is present or imminent. While enterostomy is often a life-saving procedure in simple obstruction, it is useless in mesenteric vascular occlusion because here we are dealing with a lesion which paralyzes the bowel and with a toxæmia from the absorption of autolytic products from the diseased segment. Enterostomy does not function in a paralyzed bowel, and neither enterostomy nor exteriorization prevents the autolysis or the absorption of autolytic products from the diseased area. These procedures alone or in combination were used ten times in this series and fourteen times in Trotter's<sup>60</sup> series. To this group may be added three cases which the author saw as a resident physician, in two an enterostomy was done and in the third an exteriorization. Death ensued in each instance except one. This was a case of Trotter's<sup>60</sup> in which the lesion was not sufficient to interfere with peristalsis.

Exploration alone was done seventeen times. There were six recoveries.<sup>13 18 21 25 43</sup> In two of these the transverse colon was involved and the collateral circulation through the gastrocolic omentum was undisturbed.

Drainage was done in two instances with one recovery. In this case<sup>27</sup> an abscess cavity formed about the diseased segment and six inches of bowel sloughed through the wound. Anastomosis was done at a later date.

The usual reason for not resecting is that the patient's condition is unable to withstand the trauma of operation, or that the area involved is too great. The danger of death from a properly conducted operation is much less than the danger of death from peritonitis or toxæmia if the diseased segment is not removed. That trauma of a well-conducted operation is slight is shown by the recovery of Mitchell's<sup>33</sup> patient who was operated upon in a moribund condition without anæsthesia. Several successful operations were done with only local infiltration of the anterior abdominal wall. One of McGuire's<sup>32</sup> patients went on to normal term after seven and one-half feet of bowel were resected when the patient was four months pregnant.

The amount of bowel which may be resected without after ill effects varies. Flint<sup>54</sup> in a study of fifty-eight cases of extensive resections for various causes found that the metabolic disturbances were usually slight when less than 375 centimetres of bowel were resected. In this series there were three cases in which almost the entire small intestine was successfully removed. Doerfler<sup>16</sup> resected all but 12 centimetres of the jejunum and 20 centimetres of the ileum and the patient was well six and one-half years later. Wulsten<sup>52</sup> resected all of the small bowel except 15 centimetres of jejunum and 10 centimetres of ileum. In Sjoval's<sup>48</sup> case only 50 centimetres of small bowel remained. X-ray examination in this case showed that the small bowel took a direct course to the ileocecal valve.

Often the line of demarcation between the diseased and healthy bowel is not well defined and the question arises as to the amount which should be resected. Resection should include all of the diseased area of the bowel and mesentery and as far beyond as is necessary in order to obtain free bleeding

was no peristalsis, either spontaneous or after manipulation. The bowel walls were thickened. The bowel above and below the diseased area was dilated and lighter in color than normal, peristalsis occurred after manipulation in this area. About 60 centimetres below the thrombosed area approximately 30 centimetres of bowel was caught in an adhesive band. This segment was moderately distended and discolored. The band was severed and the bowel immediately returned to normal appearance. The mesentery of the thrombosed bowel was found to be dark red, swollen and rather tense down to its base. The infarcted area which began about 45 centimetres from the duodeno-jejunal junction was resected and sufficient healthy tissue was removed to insure free bleeding from the edges of the bowel and mesentery. A lateral anastomosis was done without the use of clamps and without drawing the bowel from the abdominal cavity. Two gutta percha drains were inserted and the wound closed.

*Post-operative Course*—The pulse could not be counted at the wrist until fourteen hours after the operation. Sixteen hours after operation the first urination occurred. Vomiting which occurred several times between the fortieth and forty-fourth hours was controlled by single gastric lavage. Flatus and spontaneous bowel movement occurred at forty-eight hours after operation.

*Medication* consisted of digifolin, 1 ampule every two hours for forty-eight hours, then every four hours for a similar period. Caffeine sodium benzoate was given every three hours for forty-eight hours. During the first twenty-four hours, 3,000 cubic centimetres of saline were given under the skin and 500 cubic centimetres of glucose with insulin were given into the vein. During the next forty-eight hours 3,000 cubic centimetres of saline and 1,000 cubic centimetres of glucose with insulin were given.

The specimen removed was measured the next morning and found to be 230 centimetres long. Microscopic examination revealed diffuse infiltration of all layers with serum and blood cells. The blood was coagulated in both the arteries and veins of the bowel and mesentery.

It is now one year since the operation and the patient is in good health, working every day.

#### SUMMARY

This paper is based upon a review of ninety-two proven cases of mesenteric vascular occlusion which have been reported during the past ten years. There were thirty-nine recoveries and fifty-three deaths, or a gross mortality of 57.6 per cent. In nine instances spontaneous recoveries occurred. In three of these cases the occlusion apparently did not cause any abdominal symptoms and the condition was found only at autopsy. In six instances the symptoms were sufficient to warrant laparotomy but no resection was done. There was one instance of sloughing of the diseased segment through the drainage wound. There were forty-three cases in which operative resection was done. The mortality in this group was 32.6 per cent. Recoveries include three cases of practically complete removal of the small intestine.

No definite symptom complex can be formulated, but the onset of acute abdominal pain not relieved by enema, accompanied by high leucocyte count, disturbed bowel function with or without collapse, tenderness, and rigidity in the presence of a disease of the circulatory system should lead one to suspect mesenteric vascular occlusion.

One cannot tell from the color of the bowel whether or not it will recover function. Enterostomy apparently is of no value in this condition. Resection of the diseased area offers the patient the best chance for recovery. In this



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FIG 1—The testicle has been exposed by an incision over the inguinal canal

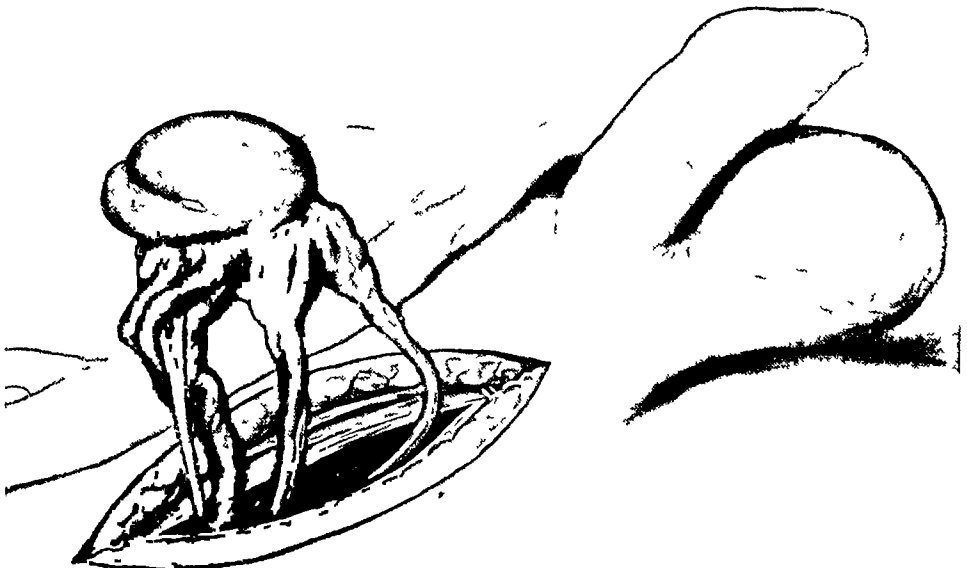


FIG 2—The testicle has been liberated. The gubernaculum the vaginal process and the cremaster fibres have been removed. The cord has been dissected out revealing its important elements. The vas is seen at the lower innermost part. The artery and veins farther up. They are seen to be separate because the connective tissue which otherwise unites them into a single cord has been removed. Only one strand of connective tissue has been left for the purpose of demonstrating an important point. It is seen at the left next to a vein and is fairly tense while the vein is partly curled up. It prevents the vessel from stretching out to its full length. After the removal of that strand the vein was lengthened by at least 2 centimetres.

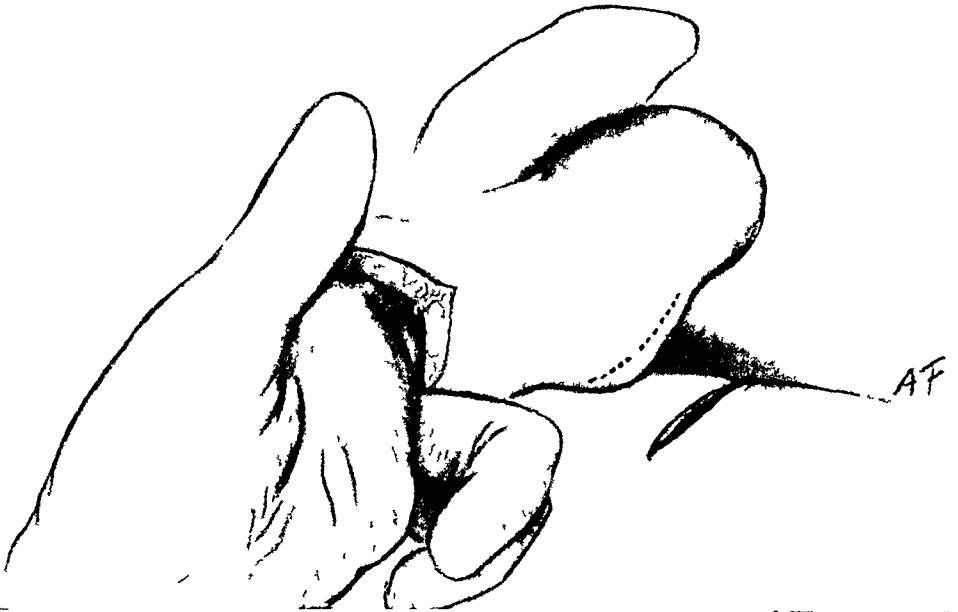


FIG 5—A channel is being made by insinuating two fingers into the loose connective tissue between the lower end of the inguinal incision and the bottom of the scrotum. Under the guidance of these fingers an incision is made in the scrotum corresponding in length and direction to that in the thigh.



FIG 6—On withdrawing the fingers (Fig 5) from the scrotum a tape has been carried along in order that the newly made channel should not get lost.

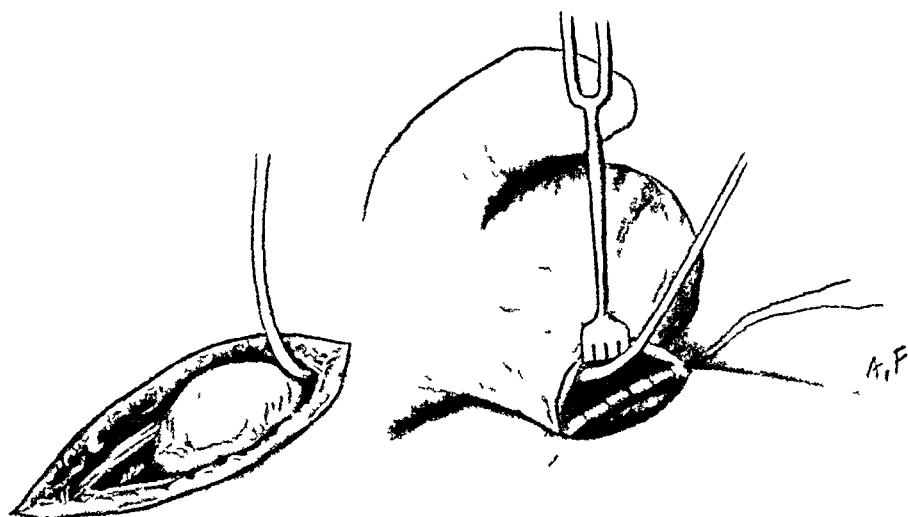


FIG 8—The entire posterior lip of the scrotal wound has been united with the upper edge of the thigh wound. All sutures were cut after tying the knot, the last one at the mesial end is still seen.



FIG 9—Under guidance of the tape which was grasped by the clamp outside of the scrotal wound, the mouth of the clamp has been carried into the inguinal wound where it grasps a small portion of the tunica propria testis at the place where the gubernaculum was cut off.

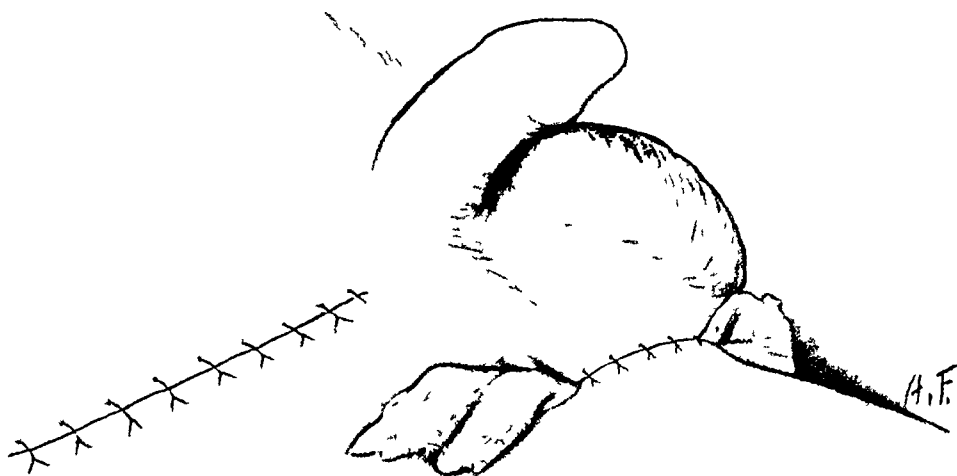


FIG 12—The operation is completed. A strip of gauze lies in the canal of skin between scrotum and thigh, it serves as a dressing for the deep suture.

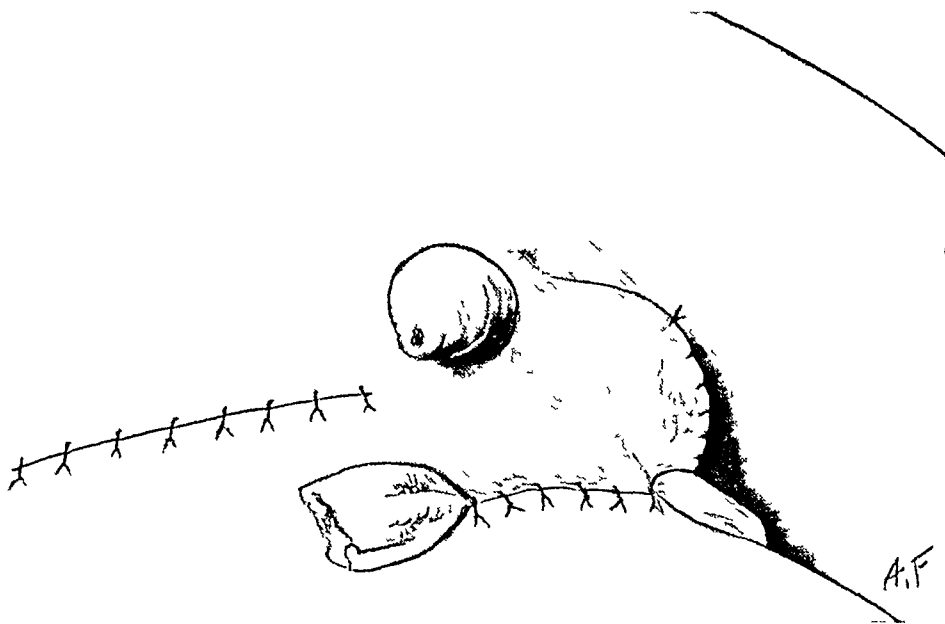


FIG 13—The completed second stage in a case of bilateral retention of the testicles. In this stage the left testicle which had been brought down at the first stage was liberated from the thigh and the wounds were sutured after which the operation on the right testicle was performed. The left inguinal scar is visible in the illustration and so are the sutures in the left half of the scrotum. The suture of the wound in the left thigh is almost completely hidden.

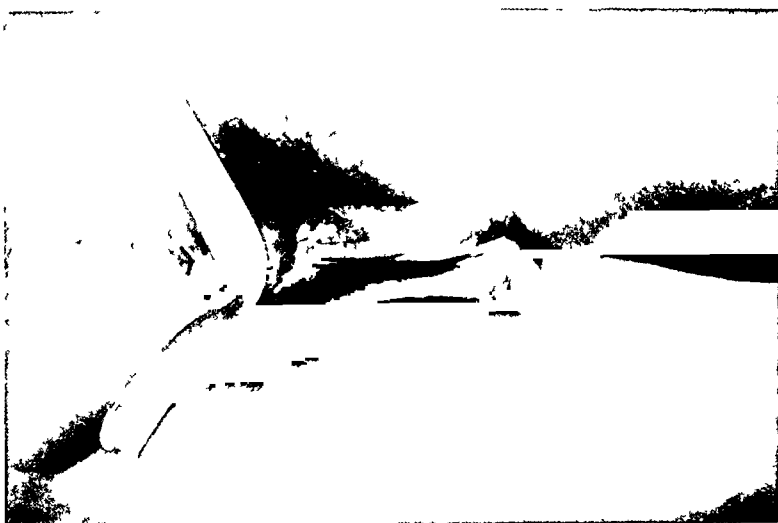


Fig. 18—A case of bilateral ectopy operated at the age of twelve and a half years after operation

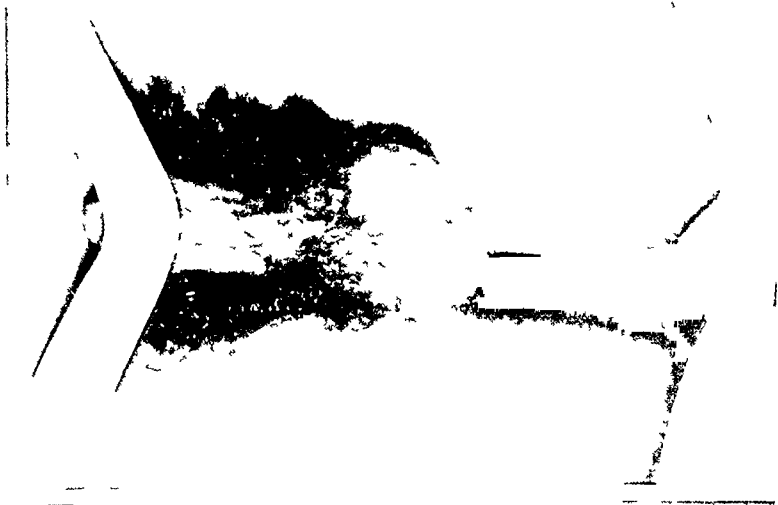


Fig. 17—A case of bilateral ectopy operated at the age of twenty-two years after operation



Fig. 16—A case of bilateral ectopy operated at the age of twelve and five years after operation

except perhaps the two end sutures. Therefore catgut is employed for this row of sutures.

The next step is that of fastening the testicle to the fascia of the thigh. The testicle, which is lying in the inguinal wound, is now to be brought down through the channel that was dug between the inguinal and the scrotal incision and which has been prevented from getting lost by the introduction of a strip of gauze or a tape. A curved clamp is made to grasp the tape at the scrotal end and with its guidance is drawn up till the tip of its jaw appears in the inguinal wound. The tunica of the testicle is grasped (Fig 9), and the organ is drawn down so as to emerge from the scrotal wound. Two sutures of fine chromicized catgut are carried through the tunica albuginea testis and the fascia of the thigh, with care not to injure the femoral or saphenous vein. Both sutures are inserted before either of them is tied, as the tying of one may render the insertion of the other difficult (Fig 10). Probably one suture would suffice.

The attachment of the testicle to the fascia having been finished, the anterior lip of the scrotal wound is sutured to the lower edge of the thigh wound. Fine silk is employed, and on inserting the stitches the tendency of the scrotal skin to turn in should again be remembered and counteracted (Fig 11).

Now the inguinal wound is closed, the first layer being the attachment of the internal oblique and transversus muscles to Poupart's Ligament (Fig 11). This layer covers the cord, as in Ferguson's method of hernioplasty which, although it is not the best method for the hernia, allows the cord to descend in the most direct way, unhampered by any possible kink due to its displacement. Should the nature of a coexisting hernia, however, make it appear desirable that the cord be displaced either according to my method of hernioplasty or any other method, this step should be taken after the dissection of the cord has been completed and before the testicle is brought down to its new location. The aponeurosis is next sutured and finally the skin.

The operation is now completed (Fig 12). With the aid of a dressing forceps a small strip of gauze is drawn carefully through the canal of skin between scrotum and thigh. It serves as a dressing for the deep skin suture. More gauze, covering scrotum and abdominal wound, completes the dressing. The removal of the sutures is done according to general principles, but it should be remembered that frequently the skin of the scrotum has been attached to the skin of the thigh with some degree of tension, so that enough time should be allowed to assure firm union. The hidden, inaccessible sutures, for which catgut was used, require no attention. The length of time in bed will be determined by a coexisting hernia, if any, in the absence of a hernia, the patient may get up as soon as a firm union between scrotum and thigh has been established.

The testicle may be released when the scrotum has stretched out to near the normal size. Two or three months will usually suffice, but there is no need of hurry, as the attachment of the testicle causes the patient no dis-

say between the ages of six and ten. The belief that it is possible for an ectopic testicle to assume its normal place is not an erroneous legend, as has been claimed elsewhere, I have seen it occur in a few cases including one of perineal ectopy. In cases where I operated at a very early age, there was always a special reason for doing so, such as strangulation of an accompanying hernia or recurring pain suggestive of strangulation of the testicle or torsion of the cord. But it would be unwise to postpone operative correction too long, as the normal development of the testicle is more likely to occur if it is brought down some time before puberty.



affected part, pain with formation of a tumor or the occurrence of trauma may call attention accidentally to the presence of a tumor which had produced no symptoms whatsoever. In time the early tenderness gives way to severe pain which is usually continuous. Occasionally, remission with diminution in the size of the tumor occurs. A moderate elevation in temperature and a slight feeling of malaise may accompany the increase in size of the tumor. Locally, there may be redness and swelling of the subcutaneous tissue or dilatation of the peripheral veins.

Local examination usually reveals a swelling varying in size from a small circumscribed mass to a large fusiform tumor, apparently continuous with the sheath of the bone. In most instances the soft parts over the tumor are freely movable. They may, however, be rather œdematous and inflamed and quite hard. The presence of osteophytes in the tumor of the soft tissue may give rise to the sensation of crepitus. The tumor generally involves the shafts of long bones and usually more than half of the shaft, the distribution progressing toward an end of the bone. It produces a widening of the shaft mainly, apparently, by the deposition of endosteal bone causing spreading of the lamellæ. The X-ray examination reveals longitudinal striations which are characteristic. Occasionally, there may be onion-like layers of periosteal bone formation similar to that seen in osteomyelitis. On the whole it is an osteolytic growth rather than osteogenic.

The tibia is the bone most frequently involved. The cortex becomes expanded and thickened. Primarily, there is no destruction nor considerable formation of bone, the tumor diffusing rapidly by infiltration. Destruction is a late manifestation and pathological fracture is rare. Metastasis takes place to membranous and cartilaginous bones, a predilection for the skull being quite noticeable. The regional glands are frequently involved. Hæmoptysis, thoracic pain and fever are usually terminal manifestations.

Although the marrow is often involved, Bence-Jones protein is not present in the urine.

Ewing's sarcoma is most frequently confused with subacute or chronic osteomyelitis. If, in doing a biopsy, the surgeon fails to go deeply enough to reach intact tumor cells, the specimen removed from the peripheral portion of the tumor infiltrated with mononuclear cells and fibrous tissue may prove to be misleading. As an example of characteristics of this disease the following case report is submitted.

CASE—S. R., male, born in Italy, sixty-two years of age, was admitted March 3, 1930, to the Crown Heights Hospital. His chief complaints on admission were pain in the right arm and shoulder, inability to move the right upper extremity, and loss of weight. His previous medical and surgical history were negative. His wife and eight children were alive and well.

The present history dated back seven months before admission at which time the patient noticed a bulging over the right shoulder. Pain on motion of the right shoulder-joint appeared at about the same period. A slight pain in the upper portion of the right humerus, even when at rest soon became quite annoying. This was followed by a marked loss of appetite associated with considerable loss of weight.

hypertrophic osteoarthritis of the spinal vertebrae. The patient was discharged against advice. He died at home early in December, 1930, after sustaining a traumatic fracture of the femur.

*Pathological Report of Specimen*—The specimen consisted of the humerus, scapula and part of the clavicle (Fig. 1). After removal of the soft parts, notably the musculature, two distinct growths were made out. The smaller growth was round, occupied the upper end of the humerus and was fused firmly to the scapula. The humerus proper was fractured right below the tumor and was easily movable, causing crepitation.

The larger tumor was oval in shape and somewhat flattened. It substituted the major portion of the scapula and infiltrated the muscles on both the anterior and posterior surfaces. Both tumors were rather soft. On section, they presented a lobular



FIG. 1.—Gross specimen showing the tumor.

structure. Their color was pale, pinkish gray, irregularly mottled by sulphur-yellow patches. These patches were opaque in contradistinction to the rest of the tumor.

*Microscopical Findings*—The tumor consisted of alternating areas of fibrous, acellular and richly cellular tissue (Figs. 2 and 3). The latter revealed scattered foci of necrosis shown by poor staining of the nuclei. In other places karyorrhexis indicated the progress of cell death.

The cellular areas occasionally showed a wealth of small cells with round, darker stained nuclei and some eccentrically arranged basophilic cytoplasm. The characteristic cells of the tumor, however, were much larger. Their nuclei were oval or irregular in shape. The chromatin of these nuclei was rather scanty, showing a discrete, dust-like distribution. The cytoplasm was quite abundant, very clear and took hardly any stain.

The arrangement of the tumor cells was quite characteristic. They showed a tendency to form groups almost like epithelial cells, yet they lined narrow channels resembling capillary vessels. Quite often, there was also a basement membrane which supported the tumor cells. These membranes were often interconnected with fibres of

and some of ten to fifteen to sixteen and twenty-six years' duration. These cases were operated upon for malignant neoplasms involving the humerus and scapula but the type of lesion was not accurately described. Then, too, the interpretation of microscopic appearance of these tumors has undergone considerable revision in the past ten years. However, the point is made that malignant disease in a situation such as this is not a totally hopeless matter and the acceptance of the radical operation should be urged.

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## IRRADIATION OF PRIMARY OPERABLE CARCINOMA OF BREAST

DR BURTON J LLL presented cases of primary operable carcinomas of the breast to illustrate a method of treating these patients by measured tissue doses of irradiation. Until about one year ago the routine procedure in primary operable carcinomas of the breast at the Memorial Hospital was to give a high-voltage cycle over the breast and drainage area as a pre-operative measure. Approximately three weeks after receiving this pre-operative irradiation the patient received radical amputation. When the wound was well healed and the patient in good general condition—which was usually the case in about four weeks after operation—a similar post-operative X-ray cycle was given. When the tumors in these patients were carefully studied grossly and histologically after amputation it was found by Doctor Ewing, in the pathological laboratory, that the cellular degeneration in the tumors was only of a slight degree and that the tissue changes in the environment of the tumors were not of marked degree. Although the use of pre-operative X-ray gives a certain degree of tumor sterilization and change in its environment which is favorable to the ultimate end-result it was felt that some means of more effective irradiation should be applied in these patients if complete tumor devitalization was to be accomplished.

Therefore, during the past year the primary operable cases to be subjected to radical amputation have received a measured tissue dosage of pre-operative X-ray combined with interstitial radium by means of the introduction of gold radon seeds or gold radon wires. With the help of the physical laboratory it has been possible to translate the dosage received by the tumor into treatments of skin erythema unit dosages which would have been delivered had the high voltage X-ray alone been employed. Studies in the pathologic laboratory have revealed that complete devitalization of cancer of the breast can be accomplished in the average case by the administration of the equivalent of ten to twelve skin-erythema units. It is obviously impossible, with our present methods of external irradiation, to administer this dose by any external means. This is the reason for the present method of interstitial irradiation which always follows external irradiation. They had taken account of the possible hazard to the patient of the insertion of these radon seeds by means of needle trocars directly into the tumor. Theoretically, one might feel that tumor tissue at the end of such a needle might be introduced into an open lymph or venous channel. Up to the present time, they had seen no instance of diffuse metastasis following this method and they do not believe it occurs, but sufficient time has not elapsed to thoroughly prove or disprove this point. Under this method complete tumor devitalization has been accomplished. Somewhere over one hundred cases have been treated along the lines outlined. At present all primary operable cases entering the Memorial Hospital are divided into one of three groups without selection.

*Group A*—High-voltage X-ray cycle plus interstitial radon using a measured dose of ten to twelve skin-erythema doses and a comparable amount is given into the axilla. Six weeks after the introduction of the radon a radical amputation is performed. In order that they may be convinced of the efficacy or ineffectiveness of this method, no post-operative radiation is being given in this case which would complicate their conclusions.

*Group B*—Radical amputation is being withheld entirely, reliance being placed upon the use of radiation alone by means of the high-voltage X-ray and interstitial radon—measured dosage being the same as in the cases subjected to radical amputation.

Keynes, at St Bartholomew's Hospital in London, has been so impressed by the results of small doses of radium buried in the breast and its lymphatic drainage areas for several days at a time that he now prefers interstitial irradiation to operative removal even in early breast cancer. As he points out, however, implantations are attended with some dangers. He knows of cases in which radium needles have damaged the internal mammary and axillary vessels, and have punctured the heart or pleura—in one case the needle dropped to the bottom of the pleural cavity. He has seen skin implantations at the site of needle punctures. In one case of early breast cancer, known to the speaker, preliminary roentgenograms of the chest and bones were negative before radium implantations but the patient died of widespread dissemination three months later. The result might have been the same in the absence of irradiation but the possibility of the implantation needle having opened a vein for the cancer cells to pass into the general circulation cannot be dismissed. Interstitial irradiation, to be effective, has to be pushed to the limit with resulting necrosis in some cases that calls for limited excisions. These various mishaps affect only a very minor percentage of cases and by no means contraindicate the intelligent use of interstitial irradiation in patients not subjected to operation.

In the past few years, Doctor Carnett said he had become more and more impressed with the frequency with which cancer is disseminated widely through the breast. Cheatle has stressed this point. The speaker sends specimens of many of his breast amputations to Wainwright, at Scranton, and from them he prepares large microscopic slides by Cheatle's technic, giving a bird's-eye view of the breast, pectoral muscles and axillary contents. A study of these slides, and the experience of pathologists with whom the subject has been discussed, indicates that cancer is commonly far more widespread in the breast than is generally believed.

Doctor Carnett declared himself to be an ardent advocate of Handley's theory of lymphatic permeation, but in addition to the lesions that may occur in the breast from that process, he believed other distant breast extensions occur from fairly rapid dissemination of cancer cells along the milk ducts. In view of these considerations effective treatment demands that the interstitial irradiation should include the entire breast. Doctor Lee limits the breast irradiation to the section in which the primary lesion is located and judging from some recent motion pictures of Keynes' technic it is doubtful if the latter's method is adequate to irradiate the entire breast. Cheatle's technic aims at inclusion of every part of the breast. Whatever method is used on the breast itself the lymphatic pathways beyond the breast must receive attention. Doctor Lee has given this in his cases. Further experience is needed to determine the best method for implanting needles in the lymphatic areas. Handley has demonstrated the need for inclusion of the region along the internal mammary vessels homolateral to the breast lesion. External irradiation should precede the introduction of needles or hollow wire and the

the maintenance of an equitable temperature for the testes and by the action of the cremasteric muscle, the function of the testes is enhanced. Therefore, the Torek operation offers the best end-results because by this operation we can have a properly constructed scrotum.

One operates, therefore, in order to restore function to an otherwise aspermatic testis.

Should one operate for fear of malignancy of the undescended testis? Statistics vary greatly concerning the question of the malignancy of the testis in this condition. Bland-Sutton states 75 per cent of testes retained in the abdomen become malignant. All observers are agreed that the misplaced testicle does predispose to malignancy. It has been suggested that the inguinal testis is more liable to trauma. Coley states that, in his opinion, trauma is the cause of 33 per cent of cases of malignancy of the testis. An abdominal testis should not be removed for fear of its becoming malignant, but, if an inguinal testis cannot be placed in the scrotum, it should be removed for fear of trauma and possible resulting malignancy. One is frequently asked to place an undescended testicle in the scrotum because of the cosmetic effect.

Physical requirements for certain positions, notably the police and fire departments of larger cities, bar an applicant who has an undescended testicle. This rule, which may be too drastic, was adopted because of the more frequent occurrence of malignancy of the undescended testicle and the greater danger of trauma to the inguinal testis.

*When should one operate?* The operation should be performed before the age of puberty. The testis remains unchanged from birth until about ten years of age, after which it continues to develop until puberty. It is agreed that the age of choice for the operation of orchiopexy should be before the age of puberty, preferably between the age of from five to twelve. If a child has a large hernia associated with an undescended testicle it may be preferable to operate earlier than five years of age.

*How should one operate?* Doctor Owen stated he had not personally operated by the Torek method. He termed the operation the Torek method because of the fact that the Keetley technic suggested that the testes be fastened to the fascia of the thigh by sutures through the gubernaculum. This was for the purpose of traction, whereas Torek sutured the testis to the fascia of the thigh without traction. Any operation requiring traction usually terminates unsatisfactorily.

He had employed the technic of Bevan and found that it was unnecessary, excepting in a very small percentage of cases, to cut the spermatic vessels. This point has been recently emphasized by Bevan. Usually, it suffices to cut fascial bands about and around the spermatic vessels and the vas, and by these measures the testis can be placed in the scrotum without traction.

He has used in two cases the method of Ombredanne. The objection to this method is that it places two testes (when the case being operated upon

of the lamina, leaving undisturbed the spines interspinous ligaments, arches and muscular attachments of the opposite side, the advantages are obvious. For the cervical and lumbar regions the rather free mobility of the vertebral column makes it desirable to expose these regions so as to have all of the mobility and not jeopardize the stability of the vertebræ. While it is true that dislocation of the vertebræ following bilateral laminectomy occurs but rarely, a number have been reported. With the advent of high-speed travel this precaution to maintain stability is all the more indicated. It is an axiom of modern surgery to disturb anatomic and physiologic conditions as little as possible, and for this reason, if for no other, hemilaminectomy offers many advantages over bilateral laminectomy since free exposure of the cervical and lumbosacral regions of the spinal cord can be obtained.

Certainly no one today would think of exposing the brain by biting away bone and leaving a needlessly large cranial defect as was done a few years ago instead of making an osteoplastic flap. Likewise, he thought that the same conservative attitude toward laminectomy in the cervical and lumbar regions will be observed and whenever possible hemilaminectomy will be done in place of bilateral laminectomy.

Hemilaminectomy has its limitations as well as its advantages. Whenever a spinal-cord tumor cannot be readily removed by hemilaminectomy the exposure should be converted into a bilateral laminectomy. This can easily be done and may require the removal of only one or two arches of the opposite side, thus doing a bilateral laminectomy immediately overlying the tumor and not needlessly above or below the tumor.

Hemilaminectomy of either the cervical or lumbar regions is indicated in the following conditions:

(1) Lateral and ventrolateral spinal-cord tumors

(2) Spinal-cord tumors involving the vertebræ with partial destruction of the vertebræ

The operation has been used in these conditions in the patients whom he was showing to them that afternoon. In each, the spinal cord was adequately exposed and the pathologic process adequately dealt with. The spines, the arches and the muscular attachments of the opposite side have all been retained.

(3) Unilateral dorsal-root section and unilateral chordotomy

(4) As an exploratory procedure especially in obscure and baffling spinal-cord diseases when visual proof of the actual conditions is desirable

Hemilaminectomy is not presented to replace completely bilateral laminectomy but it has a definite and valuable position in neurologic surgery. Criticism of this procedure has almost invariably come from those who have not tried the operation. The time has come to replace hypothetical criticism by that gained from actual experience with the procedure.

DR CHARLES H. FRAZIER said that as to the propriety of substituting a unilateral for a bilateral laminectomy, obviously the only objection to the con-

had a dislocation at the thoracolumbar junction following a complete laminectomy of the eleventh, twelfth thoracic and first lumbar vertebræ. He had thought before listening to Doctor Taylor's remarks that dislocation of the spine following complete laminectomy was not something to be feared.

It can be stated that the above-mentioned case coincides with all the faults that he expounds against complete laminectomy.

DOCTOR STOOKEY, in closing the discussion, said that whether in hemilaminectomy or bilateral laminectomy, the wound was closed in layers. However carefully done, closure of dorsal-neck musculature cannot prevent ventral displacement of the vertebral bodies, from which both arches and spines with their muscular attachments have been removed. Doctor Frazier's reference to regeneration of the arches after bilateral laminectomy prompted Doctor Stookey to wonder in what percentage of cases in Doctor Frazier's series this had occurred. Regarding blood within the subarachnoid space, this can be as carefully avoided by hemilaminectomy as by bilateral laminectomy. Doctor Stookey regretted that Doctor Frazier had not had occasion to give hemilaminectomy a trial, being sure that he would find additional uses for this procedure. At almost each discussion of hemilaminectomy someone has presented from personal experience another instance of dislocation following bilateral laminectomy. He called attention to Doctor Shallow's remarks concerning a forward dislocation of a lumbar vertebra with instant paraplegia following bilateral laminectomy.

#### HÆMATOLOGIC STUDIES AS A BASIS FOR DETERMINING THE SURGICAL RISK IN JAUNDICED PATIENTS

DR RICHARD LEWISOHN read a paper with the above title for which see page 80. For remarks in discussion by DR I. S. RAVDIN see page 86.

#### TREATMENT OF EMPYEMA AND LUNG ABSCESS BY PACKING

DR JOHN F. CONNORS (New York) read a paper with the above title, for which see page 38.

*Discussion* by Drs John B. Flick and George D. Stewart. See pages 53, 54.

#### STUDY OF CASES OF CARCINOMA OF THE STOMACH TREATED AT THE PRESBYTERIAN HOSPITAL OF NEW YORK, 1916-1930

DR FORDYCE B. ST. JOHN (New York) said that from January, 1916, to December 31, 1930, there were 365 cases admitted to the Presbyterian Hospital of New York with a diagnosis of carcinoma of the stomach. Of these, 120, or 32.9 per cent, received no surgical therapy and would therefore not be considered. Resection was carried out in sixty cases, or 16.4 per cent, of all the cases admitted. Palliative gastroenterostomy was performed in seventy-five cases, a simple exploratory celiotomy was done in eighty-five cases and in the remaining twenty-five cases some emergency procedure such as jejunostomy or gastrostomy was done.

Of the cases in which only a palliative operation or a simple exploration



of long-standing cure. What was needed was to find some way to operate on cases of carcinoma with a short history and thus still presented difficulties. Another interesting point brought out by Doctor St. John's figures was the high immediate mortality following resection, it is very much higher than in resection for ulcer.

#### BILATERAL PHRENICECTOMY FOR PERSISTENT HICCOUGH

DR OTTO C. PICKHARDT presented a woman, thirty-three years of age, who was admitted to the Leno\ Hill Hospital July 12, 1930, on account of various gastric disturbances and especially of a hiccough which, with various periods of remission, had persisted for five years. At the time of her admission, she had been suffering from the condition for two months. She had enjoyed good health until twelve years before at which time, after a forceps delivery, various pelvic conditions supervened which culminated in a pan-hysterectomy done in 1925. Since that time she had never been well, having suffered from a combination of infected conditions of the pelvis. The first attack of hiccoughs occurred during the convalescence from the hysterectomy in 1925 since which date attacks have recurred of varying periods of duration. In 1928, following a cystoscopy, she had an attack lasting ten days, in 1929, two attacks, one eighteen days and one twenty-eight days. For the past six months, there have been many attacks lasting for an hour or more. The present attack, which has determined her present hospitalization, began two months before admission and has continued, excepting for occasional intervals of one day, without relief, except when the patient has slept. The attacks are characterized first, by nausea, then vomiting, then gastric distension and then hiccoughs with expulsion of large amounts of gas. The woman has been subjected to a great variety of treatments by various specialists, hospitals and clinics. The treatments tried have included

- (1) Spinal tap in the Bayonne Hospital which stopped the hiccough for several hours
- (2) Gas anaesthesia which caused convulsions at the time and afterwards
- (3) Hypos of atropine and morphine which sometimes made the patient vomit
- (4) Daily colonic irrigations—no relief
- (5) Cystoscopy—the patient "stopped breathing for twenty minutes"
- (6) Chloroform anaesthesia, hiccough stopped only while the patient was anaesthetized
- (7) The threat to cut the phrenic nerve made the patient sign a release, and on her return home the hiccough stopped
- (8) Ice bags to the throat, chest and abdomen had no effect
- (9) Pure oxygen breathing had no effect
- (10) Many medications by mouth, none of which were effective for more than a few minutes

The patient was a well developed, moderately nourished, white woman who was hiccoughing at ten-second intervals. Physical examination was essentially negative, weight, one hundred and one pounds. By the fluoroscope, while hiccoughing, both sides of the diaphragm could be seen to move in a jerky manner with normal excursion.

On July 18, at 3 P. M., 5 cubic centimetres of  $\frac{1}{2}$  per cent novocaine solution were injected into and toward the right phrenic nerve region. The hiccoughing immediately ceased and the patient went into sound sleep, was quiet until the next day at 1 P. M., when the hiccoughing returned.

interspaces between the height of inspiration and expiration. On deep breathing there was a distance of one interspace as an average. The costo-phrenic angles are clear and the diaphragmatic dome is normal in appearance. The findings contrast sharply with the examination following the operative procedure, when the diaphragmatic excursion was a small fraction of the present finding.

Doctor Pickhardt said that he presented this patient to show that (1) Plentiful and sufficient respiration can be carried on with at least more than partial paralysis of both diaphragms, artificially produced simultaneously. (2) Forced hiccoughing of minor character and short duration can occur under these conditions. (3) To illustrate early and late changes in the position and excursions of the diaphragm. (4) This operation is feasible in nontoxic cases.

DR GEORGE P. MULLER (Philadelphia) said that he had never performed a bilateral phrenicectomy, by which he meant an exeresis of the nerve, and had not had a case of such long-continued hiccough as the one reported by Doctor Pickhardt.

He had, however, had occasion to practice bilateral interruption at one stage of the phrenic impulse by freezing on five occasions, and, while the singultus was cured, the diaphragm continued to move as seen by the fluoroscope shortly after operation, showing evidence of the transmission of motor impulses below the level of freezing by way of the accessory derivation. In two of these patients hiccough was the reason for the operation and in both, cure was obtained which was lasting for at least six months in one patient, at which time he was not followed further and for two years in the other, at which time he died of cerebral apoplexy. The other three patients were operated upon for that curious condition of tachypnoea, or diaphragmatic tic following encephalitis.

The first case was reported in 1925 by Gamble, Pepper and Muller, himself, and for a period of at least five years, the end of the observation, the patient had remained well.

The second case occurred in a young girl in whom the post-encephalitic manifestations were pronounced. She was relieved by the phrenic nerve freezing and has continued free from diaphragmatic spasm although still suffering from cerebral manifestations of her encephalitis.

The third case was one of mild encephalitis who developed tachypnoea and was temporarily relieved by drinking water. Gradually the water-drinking increased until the time when first seen by the speaker he was taking from thirteen to fifteen quarts of water daily. The phrenic nerves were frozen and after that the patient was unable to develop hyperpnoea although the polydipsia persisted, and it was necessary to put him on an allowance of about 4000 cubic centimetres in the day. He was much improved a number of months later, at which time he was lost from observation.

In 1922, Neuhofer reported the case of a boy eight years old on whom bilateral phrenicectomy had been performed and three years later the diaphragm was still found to be practically immobile. The boy had developed normally,

The stroma, though very cellular, is composed of nuclei also fairly regular but mitoses are not infrequent. It cannot be considered a benign tumor although it probably has arisen in the myeloid cavity. The older portions of the stroma are less cellular, there is no cartilage, but very early osteoid areas may be found."

At the suggestion of one of the members, a vote was taken on the operative procedure to be followed. Eight members favored a high thigh amputation, thirteen curetting and implantation of radium, four resection of the knee, and one advised that nothing be done. A simple curettage of the bone and surrounding soft parts was done, and a cavity about the size of the fist was the result, this was immediately closed by means of a pedicle



FIG 1—X ray of femur ten years after



FIG 6—Condition of cavity at the present moment

muscle graft taken from the vastus externus. November 19, 1930, the patient, with his present X-rays, was again shown before the Society of Clinical Surgery at a St Luke's meeting. He has a perfect functional result. Note in the recent X-rays that although the bone cavity has been materially reduced in size it has not been entirely filled with bone but is in all probability filled with fibrous tissue. (See Fig 1)

The second patient had a large osteomyelitic cavity of the head of the right tibia which was closed by a pedicle muscle graft with attached skin button. The history of this patient was. While leading his squad against a machine-gun nest in the Argonne, October 1, 1918, he was wounded by a bullet which passed through the femur and knee-joint, and came out through the head of the tibia. He made the usual round of military hospitals and

of an osteomyelitic cavity of the right tibia After seven and one-half months, the wound, despite good surgical treatment, is represented by a granulating trough-like wound  $4\frac{1}{2}$  by  $1\frac{3}{4}$  by  $1\frac{1}{2}$  inches The wound was first sterilized by the Carrel method and a stent of dental wax molded to fit the cavity The stent was wrapped with the skin grafts in such a manner that the epithelial surface was against the stent and the whole placed in the cavity Eight days later the stent was removed, and 80 per cent of the cavity was found to be covered by a healthy epithelium In twenty-seven days the surface of the cavity was completely epithelialized The cavity is greatly diminished in size

Doctor Lyle has found these three simple procedures valuable in solving some of the problems of reconstructive work

DR B FRANKLIN BUZBY said that his own experience with the transplant of muscle in these cases had been rather bad, every patient has had considerable post-operative pain He was sure he had put in muscle and fascia alone without any sensory nerve In the small cavities one can use bone fragments

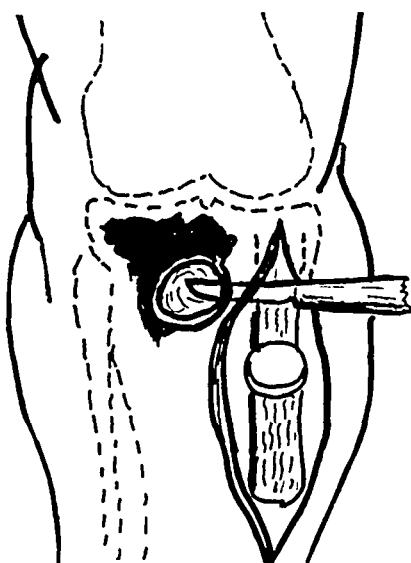


FIG 4—Illustrating the technic of closure of pedicle muscle flap with attached skin button (third step)

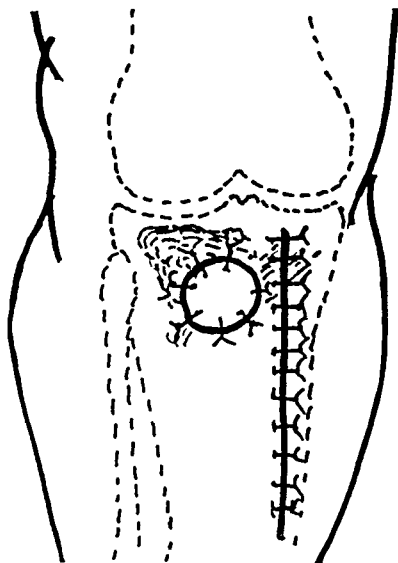


FIG 5—Illustrating the technic of closure of pedicle muscle flap with attached skin button (final step)

obtained nearby with rapid subsequent recalcification in the cavity The type of cavity to be filled in decides the type of graft In the compound fracture case he believed a long way around was taken to secure the same result that could have been obtained by using the Orr technic in the beginning Ordinarily, cases of tibial osteomyelitis heal in six months or less with satisfactory skin and with the bone level almost up to where it was before operation In the bones entirely surrounded by muscle the same procedure is adaptable as well, as the bones will fill out to the proper size if sufficient time elapses and secure packing is kept in place The speaker had a patient from whom he removed an area in the tibia six inches long and in less than six months the tibia was filled out to where it was before operation In the femur and the

time a lumpy condition in the outer portion of her right breast. These lumps were a little sensitive but gave no real trouble. Two subsequent children were nursed from both breasts. While nursing the first of these the patient had an attack of painful swelling of the right breast which subsided without treatment. Several months later the breast began to have a peculiar shape, and soft areas, apparently containing fluid, were noticed.

In May, 1925, when her last child was fifteen months old, there was a second attack of pain in the breast which caused the patient to seek medical advice. Many diagnoses were made, including cancer, with a recommendation of radical amputation. Following this advice the patient presented herself at the New York Skin and Cancer Hospital for treatment.

*Examination*—Both breasts are pendulous. In the right breast, occupying chiefly the outer hemisphere and the areolar region, are large, tortuous, soft, fluctuant areas which more than anything else suggest huge varicose veins. The general course of these tortuous swellings is from the region immediately about the areola and nipple toward the anterior border of the pectoralis major muscle and the axilla. They conform in position and direction to the main

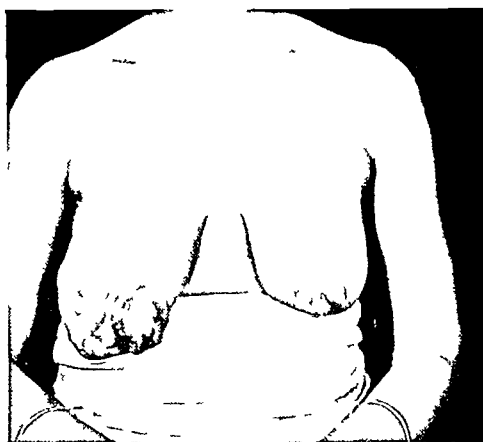


FIG. 7—Appearance of patient when first examined showing lymphatic varix of right breast.

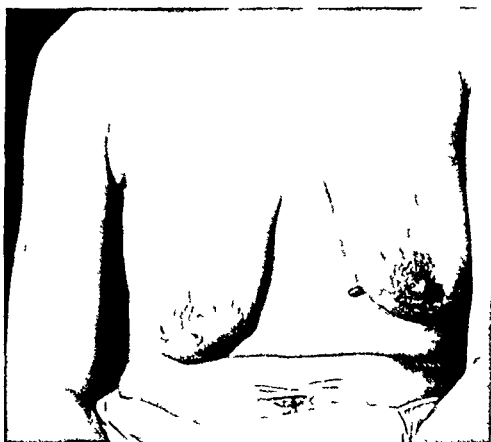


FIG. 8—Appearance of patient two and a half years after coagulation of lymphatic fluid in varix.

lymphatic trunks of the breast. Along the course of these trunks toward the outer zone of the breast some areas of induration are felt. The induration is not the resistant type associated with malignancy. There are no enlarged lymph-nodes in the right axilla nor above the clavicle. There is one small, rather firm node at the anterior border of the pectoralis major muscle. The right arm shows no swelling and appears normal as compared with the left. Two irregular scars are seen on the medial surface of the right arm, one in the epitrocheal region, the other about mid-way between the elbow and the axilla. The left breast and axilla appear to be normal.

The unusual character of the lesion and the history of filarial infection suggested the possibility that a relationship might exist. A needle was inserted in one of the fluctuant areas of the breast and about 10 cubic centimetres of clear straw-colored fluid were withdrawn. A microscopic examination of this fluid revealed a number of active embryonic filariæ. One of the living parasites was found in a fresh blood preparation. The urine did not show parasites nor chylous fluid. The blood Wassermann reaction was negative.

With a tentative diagnosis of filarial lymphatic varix, the question of treat-

The quantity which could be introduced at the time was insufficient to distend the varices, so the attempt was given up

Two days later, the patient developed severe pain and swelling of the right breast with local and general elevation of temperature and chills. The attack subsided without abscess formation. When an examination was made a few days later, it was found that the fluid in the varices had coagulated. There was subsequently a slow resolution of the process with a return of the breast practically to normal. Recent attempts to microscopically demonstrate filariæ in the blood have been unsuccessful.

*X-ray Demonstration of Parasites*—Following publication of the work of O'Connor, Golden and Auchincloss<sup>10</sup> on the revelation of calcified filariæ by X-rays, an attempt was made to demonstrate the dead parasites in this patient. In the right arm were found small oblong shadows believed to represent dead, calcareous filariæ.

*Discussion of Treatment*—No effective systemic therapy for filariasis has been discovered. Treatment, therefore, is directed toward the relief of local manifestations. Matland<sup>11</sup> reported good results from the local removal of adult filariæ when they could be located. O'Connor<sup>12</sup> has likewise reported long remissions of filarial lymphangitis following the injection of sulpharsphenamine with novocaine directly into areas believed to contain adult worms. It is conceivable that patients who have moved to temperate climates and are, therefore, no longer subject to reinfection may be cured by local destruction of the parent filariæ.

In the case of this patient, disappearance of lymphatic varix followed the injection of lipiodol directly into it. This result may have been due to the lipiodol, or to trauma incident to its injection, or there may have been no causal relationship.

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an area 4 centimetres in diameter which appears entirely similar to the rest of the tumor but is considerably softer. The tumor has extended down into the kidney pelvis and out to the capsule entirely replacing the normal kidney tissue except for two pyramidal areas at the poles. These pyramids of kidney tissue have their bases at the inner surface of the kidney and measure 1 centimeter in width at the base by 3 centimetres in height. On the anterior and posterior surfaces of the kidney the tumor may be seen shining through the capsule which is only 0.25 centimetre thick. The tumor is easily separated from the kidney tissue and capsule and while it extends into the pelvis it is not adherent to it.

*Microscopic Description*—The sections show the tumor to be very cellular in composition. The cellular elements seem to be of two distinct types, one of connective tissue origin and the other epithelial origin, with the connective tissue cells predominating. These connective tissue cells are for the most part round in form, contain large deeply staining nuclei and a scant amount of cytoplasm. The nuclei are granular and occasionally show structures resembling mitotic figures although no true mitoses were observed. Many of this type of cell, however, show transitional forms toward the spindle cell. They have no particular arrangement although there are a few fine strands of fibrous tissue running through the section and dividing it up. These connective tissue cells act as a supporting stroma to the epithelial cells. These cells are arranged in definite alveoli bearing some resemblance to the kidney tubules. The cells are larger than tubule cells, have darker and more granular cytoplasm and larger, more deeply staining nuclei. No mitotic figures were seen. They vary in shape from cuboidal to columnar and appear one to three deep in the alveoli. Although the connective tissue cells are distinctly the more numerous, the proportion of epithelial cells to connective tissue cells varies in different sections. No muscle cells were seen. The kidney tissue appears normal except that it is greatly compressed and separated from the tumor by a layer of dense fibrous tissue which acts as a capsule for the tumor.

At present the young girl is in excellent health. Of nine cases of Wilm's mixed tumor of the kidney in children, in the records of the Roosevelt Hospital, seven died within the first year, one was alive at the end of four years, when trace of her was lost and the ninth is the patient here presented. These tumors are especially malignant, with a tendency to recur rapidly and metastasize to the liver and the lungs. The reports in the literature are so discouraging that one might well hesitate to operate because of the apparent futility of the operation. On the other hand such a result as this patient shows justifies the operation and the expectation of an occasional good result.

DR ALBERT E. BOTHE (Philadelphia) said that while the so-called Wilm's tumors are usually tumors of childhood, the majority are removed from patients several years older than the one presented. On account of the wide diversity of pathologic findings, this tumor has been tagged by many names. This, of course, is due to the wide variations in the predominating cellular growth. They are called myxomas, myxosarcomas, sarcomas, adenosarcomas, Wilm's tumors, embryomas, teratomas, and mixed tumors.

When the frequency of Wilm's tumors is compared with all tumors of the kidney in childhood, it bears about the same relation as hypernephroma does to all types of kidney tumors found in the adult.

Owing to the embryonal characteristics of the predominating cells in these tumors, it is natural to assume that they should be radio-sensitive. It is further evident that microscopic sections made from radiated and non-radiated Wilm's tumors show striking differences.

He had recently seen a girl, eight years of age, who had been operated upon for splenomegaly. When the peritoneum was opened the mass was found to be attached to the kidney. The abdomen was closed and an extra-peritoneal exposure showed a large inoperable tumor. A piece of tissue removed at the time of operation was diagnosed adenocarcinoma of the kidney.

After reviewing the microscopic sections made from tissue removed from this tumor, it was felt that it was representative of a Wilm's tumor and deep X-ray therapy was advised. Since this treatment the tumor has reduced about one-third in size. This reduction in the size of the mass will undoubtedly facilitate subsequent nephrectomy.

He had also studied microscopic sections made from a Wilm's tumor removed after having had a course in deep X-ray therapy. This girl was nine years of age with a tumor mass involving an entire left side of the abdomen. After a course in deep X-ray therapy the mass had reduced about one-half in size. This was followed by transperitoneal nephrectomy by Doctor Randall.

When the sections made from the radiated tumor are compared with the sections made from the nonradiated tumor the difference is very striking. In the nonradiated tumor there is a predominance of embryonal epithelial cells with very little stroma. The tissue has a very actively growing appearance, while the sections made from the radiated tumor show an extensive fibrous stroma with small islands of embryonal cells embedded in its meshes and considerable evidence of degenerative changes.

It is evident that the findings in the two cases referred to indicate that a preliminary course in deep X-ray therapy should facilitate nephrectomy and reduce the incidence of subsequent extension from manipulation of the tumor mass at the time of nephrectomy.

DR DAMON PLEIFFER said that many years ago he published a paper on mixed tumor of the kidney which appeared in the last number issued of the Bulletin of the University of Pennsylvania. In assembling the material for this paper he examined the literature on the subject thoroughly and collected many cases, all of which showed that this is a highly malignant condition as a rule, but that now and then a case proves to be benign. Some of the cases are very responsive to treatment so that one need not feel that these tumors are invariably hopeless, and they rate exploration at least.

#### ACUTE OSTEOMYELITIS OF THE VERTEBRÆ

DR JOHN E. JENNINGS (New York) in presenting a patient, said that acute septic osteomyelitis of the vertebræ, first described clearly by Lannelougue in 1879 and found by him once in 545 cases has been well studied by Geisel, Donati, Mathieu, Wilensky and others. It may involve either the arch or the body and may occur in any part of the spine. When it involves the arch, subperiosteal abscesses regularly develop which burrow into the surrounding structures or into the spinal canal. When the bodies are involved, pressure on the cord is apparently not so common, but the pleura, pericardium and peritoneum and dorsolumbar muscles are more often involved.

The prognosis is in any event very grave. Mathieu found a mortality of 46 in 100 cases and says that recovery occurred as a rule in the cases in which



# BRIEF COMMUNICATIONS

## INTERNAL HERNIA FOLLOWING POSTERIOR GASTROENTEROSTOMY\*

THE modern operation of posterior gastroenterostomy usually pursues such an uneventful course that any complication is worthy of note

J H (MEH No 141611), male, aged thirty-five, was first seen by me February 21, 1930. He had been operated upon six months before by another surgeon, the appendix and gall-bladder being removed. Following this operation he was well for about four months when he developed pain in the epigastrium, sometimes accompanied by vomiting, and not relieved by medicine or food, practically continuous for the preceding six weeks. X-ray examination disclosed an active ulcer on the lesser curvature about 3 inches from the pylorus.

February 27, 1930, I resected the ulcer-bearing area. There were extensive adhesions making the resection difficult. He did very well for eight months when he again developed distress. For a while under dietic measures he improved, then in spite of these measures strictly carried out the pain became unbearable. X-ray examination demonstrated a new ulcer on the lesser curvature at or near the line of resection.

A laparotomy, done December 27, 1930, disclosed an almost overwhelming number of adhesions about the pylorus and site of the resection. As further stomach resection was impracticable, a posterior gastroenterostomy was done, even this was difficult on account of the fixation of the stomach. The loops of the vessels in the mesocolon were small so that it was only with difficulty and after ligating some of the branch vessels that a sufficient amount of stomach could be brought through to allow of gastroenterostomy. An extremely short loop was used, just sufficient to allow of placing the clamps with a small strip of gauze below. Iso-peristaltic posterior gastroenterostomy was performed in the usual manner, the mesocolon being sutured to the stomach as the final step after withdrawal of the clamps, the small piece of gauze was withdrawn from left to right and a stitch placed joining the mesocolon to the stomach in the mid-line of the gastroenterostomy posteriorly. The gastroenterostomy functioned immediately, its leading-away loop descending toward the pelvis and filling out well.

For ten days the course was uneventful except for a spasmodic cough. The Fowler position was used. On the tenth day the patient became nauseated and vomited repeatedly. His stomach was lavaged, vomiting recurred and operation was decided upon. The abdomen was opened January 8, 1931, through a left rectus incision, the previous incisions having been through the right rectus. It was at once noted that the stomach was dilated and that the visible portion of the small intestine was collapsed. The adhesions to the right of the incision were too dense to allow of dissection. Immediately under the present incision, however, the field was quite clear and it was possible to easily draw up the transverse colon. The finger could be readily introduced from the stomach side into the gastroenterostomy opening. It was found that a loop of the jejunum had entered from right to left the small opening between the mesocolon and the first portion of the jejunum proximal to the gastroenterostomy. This opening at the time of the preceding operation was only sufficient to allow of placing the clamps and a thin strip of gauze. The operation had been done in the same manner as some two hundred previous posterior gastroenterostomies which I had performed, and in which this complication had not occurred. The amount of jejunum which had herniated through the opening was

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\* Read before the Brooklyn Surgical Society, March 5, 1931

adherent. If a 2- or 2½-inch loop is left adhesions are less likely to form and a hernia may result. In my own case the opening through which the hernia occurred was only sufficiently large to allow of the emergence of the tips of the gastroenterostomy clamps and a very thin piece of gauze, a shaken-out stick sponge.

To the student of gastroenterostomy there will, of course, occur various measures by which this very rare complication can be avoided or its recurrence prevented. They range from closure of the opening by a stitch or two to the suturing of the afferent portion of the jejunum to the stomach, or to the mesocolon as was done in years gone by in anterior and posterior gastroenterostomy with long loops to avoid kinking.

Moschcowitz and Wilensky advise that the afferent loop should be sutured to the under layer of the transverse mesocolon. Bryan (case particularly interesting in that it recurred) did an enterojejunostomy together with a suturing of the leading-away loop to the abdominal wall at the second operation.

Walton suggests that if there be any doubt as to the presence of such an opening the afferent loop should be sutured to the under leaf of the mesocolon.

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### LIFE-CYCLE OF A GASTRIC ULCER

#### ALTERNATING HEALING AND RECURRING

It is a well-known fact that a gastric ulcer of considerable size can disappear spontaneously without leaving a trace of a lesion on the X-ray film. Such cases have been reported by Ohnell<sup>1</sup> (37 cases), Diamond<sup>2</sup> (12 cases), and others. This phenomenon is usually called Life-cycle. No recurrence was noted in any of these cases, though some were checked up by repeated X-ray examinations extending over a number of years. They really did not represent true life-cycles. For a cycle should really mean appearance of an ulcer and its disappearance at different intervals.

I had occasion to study a case of gastric ulcer with a true life-cycle over a period of eight years. A large gastric ulcer, present in 1922, had prac-

Exploratory laparotomy revealed a firm irregular mass with a large crater on the lesser curvature near the cardia. A large number of glands were felt near the lesser curvature. The mass was considered malignant. A radical removal seemed impossible on account of its size and location. It would have necessitated a total gastrectomy. A



FIG 5—Recurrence of gastric ulcer large niche, hour glass stomach February 18 1927



FIG 6—Niche much smaller, no hour glass formation March 11, 1927

gland was removed from the omentum and the abdomen was closed in layers. Microscopic examination of the gland failed to show evidence of malignancy.

*Post-operative diagnosis*—Inoperable carcinoma of the stomach

The error of this diagnosis became evident when the patient began to improve in health following the exploratory laparotomy. An X-ray examination taken in 1923

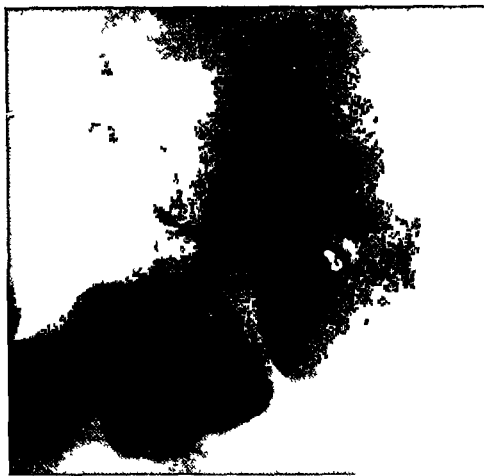


FIG 7—Niche has disappeared Hour glass formation April 11 1927



FIG 8—Stomach appears practically normal November 7 1927

showed that the ulcer had markedly diminished in size, the stomach showed marked hour-glass formation (Fig 2). A picture taken in 1924 showed that the ulcer had practically disappeared, no incisura was visible opposite the ulcer (Fig 3). In 1925 only a small pin-point elevation was visible at the site of the former location of the large crater-ulcer (Fig 4).

## BRIEF COMMUNICATIONS

His symptoms recurred in February, 1927, and a large niche with hour-glass formation was demonstrated on the film (Fig 5). During the next two months the niche decreased in size gradually (Figs 6 and 7). The stomach presented a practically normal appearance in November, 1927 (Fig 8). By this time his symptoms had subsided and he felt perfectly well. The third recurrence was demonstrated by roentgenography in March, 1930 (Fig 9). Two months later the ulcer was very small and the hour-glass formation had disappeared again (Fig 10).

It is very important to point out that this patient received neither surgical nor medical treatment.

If, at the time of the exploratory laparotomy, I had performed a gastro-enterostomy—a method still popular among surgeons in spite of its inefficacy—the disappearance of the niche would have been attributed to this operative method.

If the patient had received careful medical treatment (rest in bed, Lenhartz or Sippy diet, *etc.*), the result might have been ascribed to good effects of internal therapy. We often read in reports about this group of cases that the niche disappeared following medical treatment, implying that the treatment cured the ulcer. However, in this patient the crater-ulcer disappeared spontaneously three times without any medical regime. I have often wondered whether ulcers are really influenced by medical treatment.

I do not think that any of the disappearances of this ulcer, as demonstrated on the X-ray films, represented a real cure, but rather a diminution in size of the ulcer which was so marked as to reveal practically a normal stomach on three X-ray examinations. It is most likely that a very small inflammatory area still persisted in the intervals. Whenever re-infection occurred, the cycle started all over again.

An important lesson to be learned from this case is that even a disappearance of a crater-ulcer with normal X-ray findings does not necessarily mean a permanent cure. The ulcer may reappear at any time and may then undergo malignant degeneration.

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## BIPARTITE PATELLA

WHILE bipartite patella is an unusual developmental anomaly which has been reported by various writers, a case is reported with a review of all the literature, in order that there should be enough familiarity with this condition so that it will not be reported erroneously as a fracture, as has been done with most of the cases in the past.

year, but may be delayed until the sixth year. Occasionally, the bone is developed by two centres placed side by side. Ossification is completed about the age of puberty. Even when it arises from two centres of ossification the patella is usually one single bone, but in case fusion fails to occur, it gives rise to a bipartite patella.

Wenzel Gruber, of Petrograd, described the first case in 1883 and gave to the condition the name of "Patella Bipartite." Gruber's observations were the same as subsequent writers on this condition. He described two patellas resembling ordinary patellas, presenting at their superior external angle a deep notch in the form of a half-moon or crescent. It is in this excavation that is lodged the small fragment which is the accessory patella.

Other cases have been reported by various English and French writers, and all cases of this anomaly generally present the same Röntgen-ray appear-

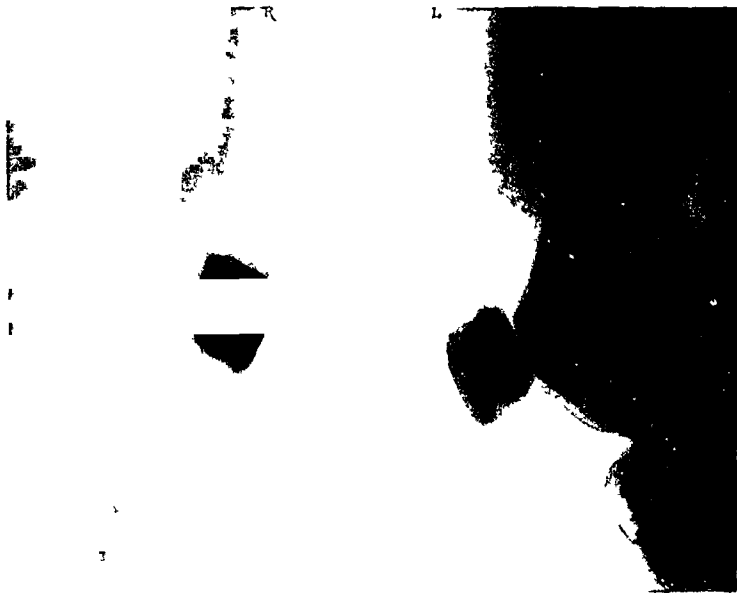


FIG 2—Showing the small fragment at the base of the patella

ance. The anterior-posterior view (Fig 1) is the most valuable and here we see that the outer and upper portion of the patella is the part which is always involved. The contour of the patella is generally not distorted. There is a definite space between the adjacent surfaces of these fragments. The separated fragment is much smaller than the main patella. Occasionally the small fragment may be divided into two parts. The space separating the main patella from the smaller bone is always uniform throughout its entire length. Fractures generally show serrated edges. In the lateral view (Fig 2), we see a small fragment of bone just above the base of the patella. One may be misled in diagnosing it as a fracture occurring through indirect violence by pull of the quadriceps tendon. But in such cases the bone is usually snapped transversely at about the junction of its lower and middle third. Fortunately most of these anomalies are bilateral.

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## THE USE OF THE ELECTRIC BREAST PUMP AS A PROPHYLACTIC MEASURE AGAINST SECRETORY STAGNATION IN THE BREAST AND POSSIBLY MAMMARY CANCER

IN A previous publication (Adair, F E, and Bagg, H, Breast Stasis as the Cause of Mammary Cancer, International Clinics, 1925, vol IV, p 19) the conclusion was drawn that mammary cancer is in large part due to the resultant irritation that follows the retention of stagnating secretions within the duct system of the breast Of 200 patients with mammary cancer selected consecutively from the breast clinic of the Memorial Hospital, 183 had at one or more times a well-marked secretory stasis in the breast Secretory stasis may be due to any one or to a combination of the following conditions, malfunction or incomplete function due to failure to nurse the child, to miscarriages and incomplete lactation, to a rapid succession of childbirths without normal intervals for proper drainage by suckling, to the non-establishment of mammary function and the consequent accumulation of stagnant cell detritus within the small ducts, to stenosis at the nipple such as the angulation of the ducts accompanying inverted nipples, or to stenosis at any point along the drainage system

A chemical irritation and inflammation is produced within the ducts and in the periductal tissues by the following causes (a) The milk is retained within the breast by artificial means, a dissolution of the milk follows into its chemical components, some of these end-products are lactic acid and butyric acid—both are marked irritants One of us (Adair) has demonstrated by chemical analysis the presence of lactic acid in stagnant human milk Experimental cancer in lower animals has been produced by the application of lactic acid, butyric acid is a much stronger irritant The tissue reactions to these irritants in and about the ducts are manifested by hyperplasia of the ductal epithelium and mononuclear infiltration of the stroma (b) During pregnancy there is a greatly increased production of new ductal epithelium and new acini in order to produce milk in sufficient quantity By the artificial cessation of lactation, this bulk of new tissue is locked within the breast to undergo sudden atrophy, desquamation and degeneration We believe this abrupt change affords another source of chemical irritation within the breast

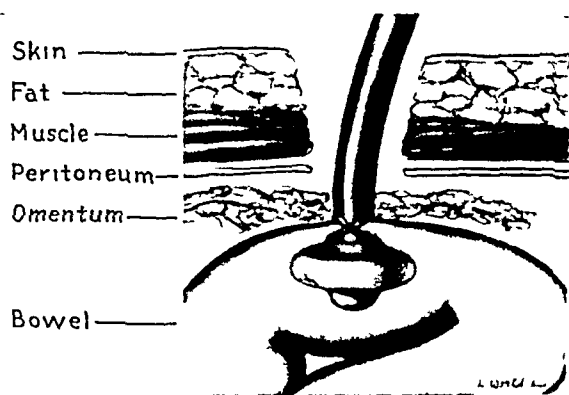
The relative frequency of cancer in the upper outer quadrant, commonly called the "tail of the breast," has been attributed to the faulty drainage incident to its greater distance from the nipple Ewing likewise has been impressed with the evidence of stagnation in the ducts leading from the segment

## SIMPLE ENTEROSTOMY TECHNIC

As the value of enterostomy is more appreciated and applied in abdominal surgery, the demand for a satisfactory plan of operation is correspondingly increased

The procedures now in vogue have certain deficiencies that, I believe, are overcome by the operation herein proposed

The method now most generally used often fails, because its execution



violates a fundamental mechanical principle, namely, if two substances of unequal density are bound together and subjected to stress or strain, the one of less density will yield under the tension, thereby destroying the union. In case of a damaged intestine, the most careful introduction of sutures will produce perforation and leakage

The plan I wish to propose is the following: Thread a Pezzar catheter on a stylette such as urologists use for introduction into the bladder. Insert the catheter thus equipped through a small opening in the intestinal wall. When the stylette is removed the expansion of the distal end of the catheter is sufficient to hold it in the lumen of the bowel. If the bowel has not undergone disintegration, one or two layers of Lembert sutures through the bowel around but not through the tube add to its security. The stem of the catheter is then passed through a small hole in the omentum and brought out at the lower angle of the incision.

When convalescence is established, the stem of the catheter is drawn out and cut as close as possible to the abdominal wall. The intra-intestinal segment is allowed to drop into the bowel to be taken care of by the natural processes of evacuation.

The accompanying illustration will serve to indicate the details of the operation (Fig. 1).

A tube thus placed acts as a means of drainage for the bowel and permits the easy escape of gas in the event of distension. It can also be utilized as a facility for irrigation and the administration of food, medication and fluids. The intra-intestinal portion in the experience of the author has always been promptly evacuated with the feces and has never caused any anxiety or uneasiness.

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Louisville, Ky.

## BOOK REVIEWS

NOGUCHI By GUSTAV ECKSTEIN 8 vo , cloth, pp 419 Harper & Bros , New York, 1931

For more than twenty-five years, the presence in the laboratories of America of an ambitious, enthusiastic, indefatigable, far-seeing laborer from Japan, was a source of inspiration and accomplishment. His death, on the African coast in 1928 from yellow fever, the origin of which he was striving to solve, tragically ended his devoted life, a life apparently brief but long enough to have added most important facts to the knowledge of the causes of disease and to have enrolled indelibly on the scroll of fame the name of Noguchi.

The book that is before us has been written, evidently, by one who was in full sympathy with the peculiar force and intense energy which characterized the subject of his pen. The book itself is more than a biography. It has all the characteristics of a novel. Noguchi himself is made to live before the reader as the portrayal of his life continues. The record follows him from his birth in a peasant's cottage in Japan in 1876, the early development of an ambition for a medical career backed by a peculiar genius for accomplishment, through the village schools of his birthplace. Driven by this ambition, he makes friends that carry him through to the medical schools in Tokio. Arrived thus far, he yearns for a wider field on the other side of the Pacific. Here he arrives, friendless and without money, to begin a career that staggers imagination. In 1900, his twenty-fifth year, he sailed for America. Beckoned on by a lure which had its foundation only in hope, he beats his way to Philadelphia where he attracts the notice of Simon Flexner and the patronage of Weir Mitchell. Finally he finds himself possessed of the resources of the Rockefeller Institute.

Not only in the country of his adoption does he pursue his labors, but into Central and South America and into Africa he extends his researches. Such problems as serpent venoms, syphilis, Rocky Mountain spotted fever, infectious jaundice and yellow fever in turn yield their secrets to his cultures and serums and to his microscope. When he died, he left the world richer than he had lived.

In his work he ever showed all the characteristics of genius—genius which has as its elements three chief components: a thirst for labor, a quickness to appreciate a cause for labor, and an ability to carry on the labor until its object is accomplished. As his biographer says, "Noguchi had the characteristics of genius, colossal energy which gave him the ability to work for weeks almost without sleep when the fire of accomplishment burned in his brain, a tremendous passion for research."

LEWIS S. PILCHER



## BOOK REVIEWS

takes place. A chapter on the pathological anatomy treats of the common variety and the second and third types, and is fully illustrated with drawings, photographs and X-rays. The articulation of the scaphoid with the astragalus where the greatest fault lies is much emphasized by the author in this and the preceding chapter as well as in the discussion of the principles of treatment.

The various theories of etiology are presented and reasons given against the mechanical theory of pressure which has been largely held responsible. The author believes it a failure of normal development, but cause unknown.

The treatment outlined is very thorough in detail and carries out the ideas stressed in the chapter on pathological anatomy—namely the deformity which takes place at the astragaloid joints. But the writer does not employ as a rule plaster-of-Paris to hold the foot in corrected position. He uses considerable manipulation two or three times a week and depends upon adhesive plaster to maintain the correction gained. Failures and relapses are acknowledged in a larger percentage of cases than are seen in this country where plaster-of-Paris is pretty generally used. Possibly his method would be preferable in the milder deformities to the American way.

The book is abundantly illustrated, contains many good suggestions and is very readable.

CHAS. D. NAPIER

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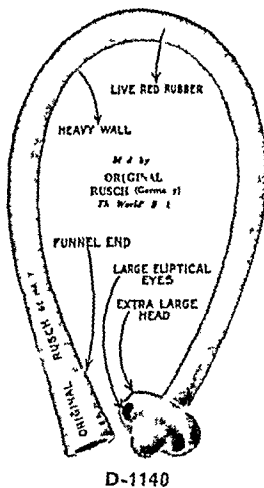
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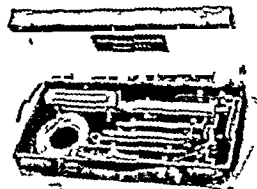
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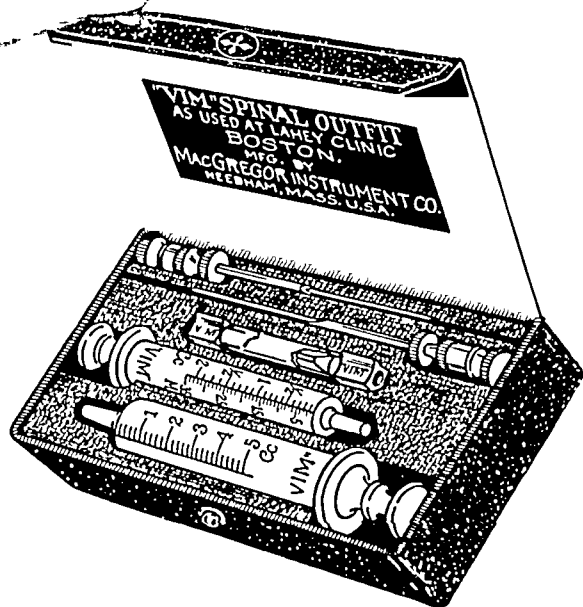
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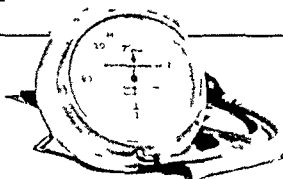
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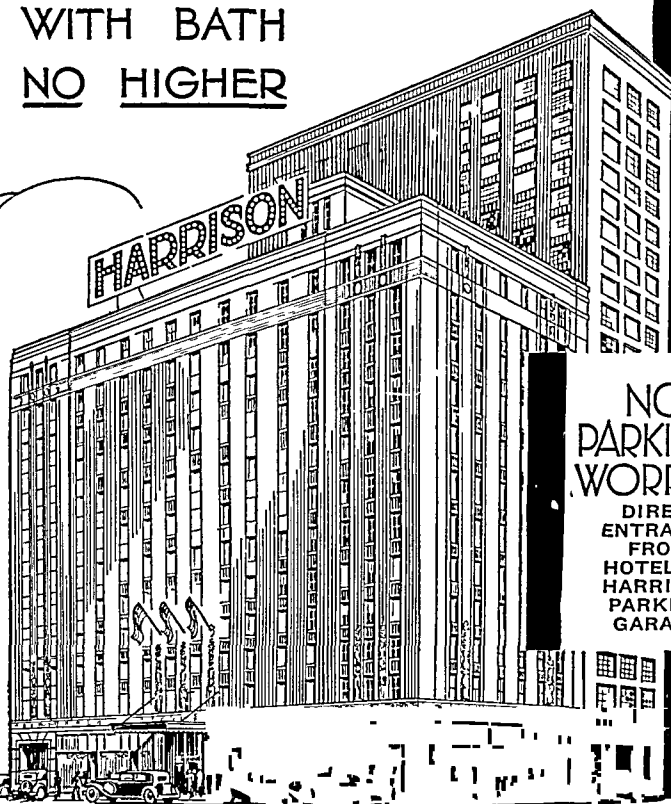
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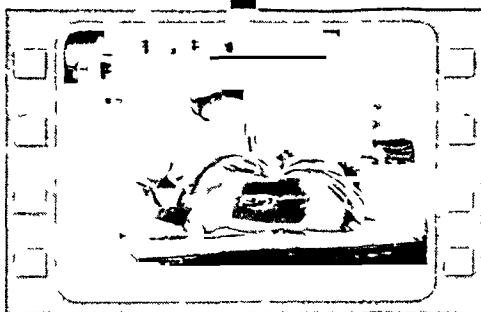
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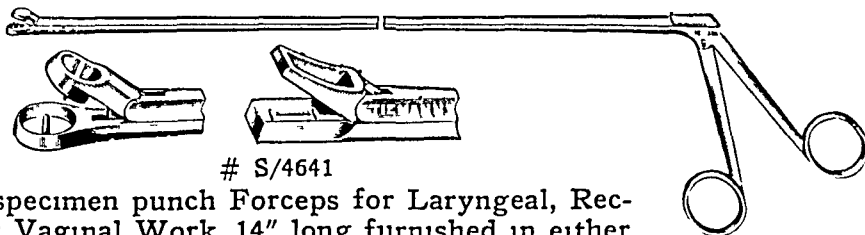
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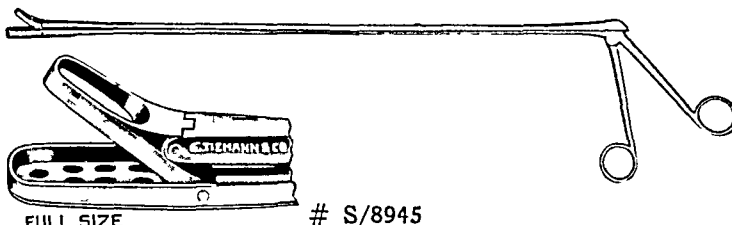
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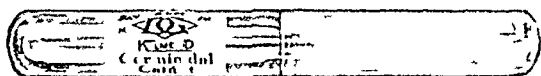
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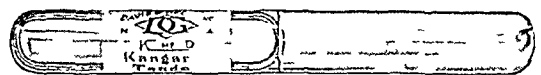
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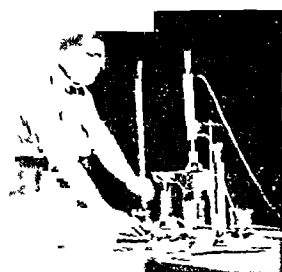


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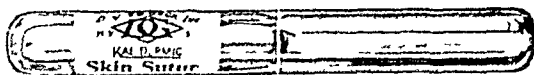


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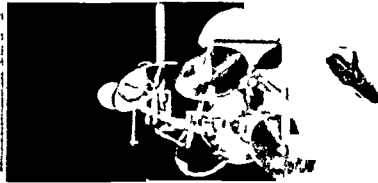
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This picture shows the position of the Operay Multibeam used for hysterectomy



When positioned for vaginal work the light is directed into the deep cavity at a convenient angle



This illustration here reproduced in miniature was made from an unretouched photograph and none of the usual stratagems for strengthening the picture were employed. The plate was exposed only during the brief interval necessary to register the figures, table and fixture and the illustration was made directly from an unretouched print. It tells its own story. The three heads almost touching are bending over the operating field directly in the path of the light. The position is for laparotomy.

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A black and white photograph of a man in a white lab coat, holding a suture needle and thread. He is looking at the camera and appears to be demonstrating the flexibility of the suture. The background is slightly blurred, showing what might be a laboratory or surgical setting.

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a heat sterilized suture  
so extremely flexible”

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**NON BOILABLE**  
STERILIZED  
*D & G Sutures*

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uses this test to select patients for sympathectomy Unless indices of 15 and more are obtained, he has not advised an operation of this type

For lack of suitable facilities one can simplify this test by making the readings with a skin thermometer and taking only one reading about an hour after the chill, which is usually three to four hours after the intravenous injection of twenty-five millions of typhoid bacteria

Great credit must be given to Brown for emphasizing the vasomotor phenomena in Buerger's disease and devising a method for selecting cases for operation In our experience, however, the vasomotor index is influenced by factors which cloud the significance of this test In the first place, the test does not always give identical values on subsequent examinations, and a great deal will depend upon how cold the extremity is when the test is started Also, the local increase in heat will depend on the activity of the inflammatory process as vessels with more active infection will light up more readily to a foreign protein than vessels in the healed stage The increase in heat, then, is not merely a peripheral vasodilation but may be an activation of an infected focus

(2) *Paravertebral Block*—White<sup>2</sup> suggested a procaine block of the sympathetic nerves on the upper or lower extremities by paravertebral injections to the first and second dorsal sympathetic ganglia if the upper extremities are tested, and a posterior splanchnic anæsthesia if the lower extremities are tested Following a successful block the rise in skin temperature is identical with the rise occurring after sympathetic ganglionectomy as the temporary block creates identical conditions with that following the operation It also imitates the effect of the operation in that pain of sympathetic origin will disappear, and thus demonstrates to the patient what can be expected from the operation

The objection to this method is that it is far from being simple As I have stated some years ago, both paravertebral block<sup>3</sup> and posterior splanchnic anæsthesia<sup>4</sup> are fraught with certain dangers and should not be carried out except for very definite limited indications It is a prerequisite of all diagnostic measures, that they be harmless

(3) *Spinal Anæsthesia*—White<sup>2</sup> but especially Morton<sup>5</sup> advocate spinal anæsthesia to decide between vascular spasm and occlusion of the lumen or whether a combination of the two exists Spinal anæsthesia blocks all motor sensory and sympathetic impulses and allows a maximal vascular dilatation Every surgeon who has repaired inguinal hernias under spinal anæsthesia must have noticed the unusual vascularity of the field

While a low spinal anæsthesia is relatively safe and simple, I do feel that its use as a diagnostic procedure cannot be advocated as a routine measure There is a vast difference between using it as an anæsthetic during operation or employing it as a diagnostic test Furthermore, as White points out, the effect of a sympathectomy, particularly in relation to pain, cannot be judged by this test as all pain tracts to the leg are blocked

As spinal anæsthesia is admirably suitable as an anæsthesia for lumbar

tibial nerve and when complete anæsthesia of the plantar surface of the foot is obtained, another temperature reading is taken at the same area. The readings are usually taken ten minutes after the injection, but occasionally, when the block is not technically perfect, one may have to wait fifteen minutes.

The block of the posterior tibial nerve at the ankle has been described before<sup>3</sup> (Fig 1).

The same principle can be carried out on the upper extremity by blocking the ulnar or the median nerves, or, if necessary, the entire wrist, and watching the rise in temperature on the fingers (Fig 2). One can also try to elicit a vascular spasm with a cold bath following a nerve block. If this is not possible, sympathectomy offers good results.

Diagnostic methods to differentiate organic occlusions from vascular

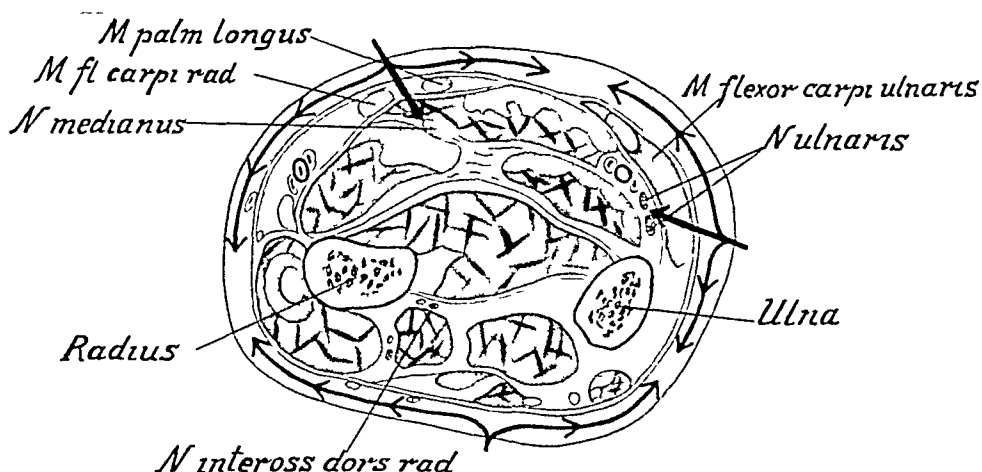


FIG. 2.—Cross section at the wrist. Block of the median and ulnar nerves and of the deep and superficial branches of the musculospiral nerve. (From de Takáts: "Local Anesthesia," Courtesy of W. B. Saunders and Company, Philadelphia, Pa.)

spasms will separate three groups of patients. With the help of this simple test, I was also able to find the identical groups in vascular disease, namely:

(a) A complete vasodilation follows nerve block. All changes are due to a vascular spasm. The actual rise in temperature is not as important as the highest reading after nerve block. Thus young individuals may have considerable vasoconstriction in their toes and may warm up rapidly. This cannot be called pathologic. More important is the level of temperature reached after nerve block. Morton and Scott<sup>4</sup> call this the "normal vasodilation level," which should exceed  $33^{\circ}\text{C}$ . In our experience it usually reaches  $34^{\circ}$  or  $35^{\circ}\text{C}$ . Readings below  $33^{\circ}\text{C}$  are subtracted from this figure and the difference obtained is the "obstruction index." In this first group there is no obstruction index.

(b) No or practically no rise in temperature takes place after nerve block. Old arteriosclerotic and diabetic patients who have an organic occlusion in the vessels show very little or no superimposed spasm. Hence the minimal

clinical purposes, the peripheral nerve block and the diathermy test are most satisfactory and simple. It is not the purpose of this paper to discuss treatment except to point out that an exact differentiation of the organic and spastic components in obstruction leads to a better understanding of the objects of treatment. While in organic obstruction the aim of therapy consists of (1) increasing collateral circulation, (2) relieving pain, (3) removing dead parts of the limb by amputation, in spastic occlusions the relief from spasm, with physical means, drugs and sympathectomy are logical procedures. Thus these patients are not medical or surgical cases, but individuals suffering from peripheral vascular disease, and combined efforts of group clinics can give them the maximal benefit.

## SUMMARY

A simple classification of organic and spastic vascular occlusions is presented. Methods of differentiation with typhoid vaccine, paravertebral block and spinal anaesthesia are described. Two new methods with peripheral nerve block and diathermy are suggested. Both procedures are simple and can be carried out on ambulatory patients. They make for a better understanding and a rational treatment of peripheral vascular disease.

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2) The normal ligament, as observed during a laminectomy, is one or two millimetres thick and distinctly yellow in color

CASE I—(E B Towne) *Compression of the cauda equina by thickened ligamenta flava, causing flaccid paralysis of right lower extremity. Restoration of normal function after removal of thickened ligaments*

S. S., a Portuguese laborer, aged fifty-three years, was admitted to the Southern Pacific General Hospital October 19, 1929, complaining of pain and weakness in the right leg.

*Past History*—He was born in Portugal and had always done heavy manual labor. He had had pneumonia, malaria, gonorrhoea and syphilis, and the last had been treated by intravenous injections. There had been intermittent discharge of pus from both ears for many years, frequent head colds, occasional sore throats, and painful urination with recent difficulty in starting the stream. Otherwise, the past history was negative. He could remember no injury to the back. He used a moderate amount of wine and smoked very little. His wife and six children were alive, one boy aged sixteen was mentally

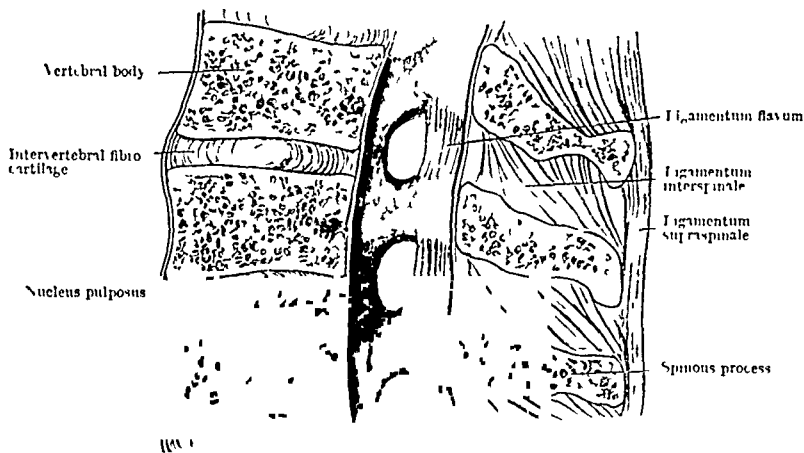


FIG. 2.—Median section through a portion of the lumbar part of the vertebral column. From Cunningham's Anatomy. Wm. Wood & Co., N. Y., 1918.

defective and was a ward of the Juvenile Court, but the other children were mentally and physically normal.

*Present Illness*—About five or six weeks before admission he began to have pain in the right lumbar and sacral regions, which soon extended down the back of the right thigh and leg. The pain was always made worse by motion and relieved by rest, and it gradually became more severe. Shortly after the onset of the pain, he noticed a progressive weakness and numbness of the right leg. For a week before admission the pain had been very severe, and weakness had increased so that he could walk only with the help of a cane.

*Physical Examination*—The patient was a poorly developed and poorly nourished man 5 feet, 6 inches tall, weighing 130 pounds. Temperature was 98.6°, pulse rate 82, respiratory rate 18, blood pressure 164/90. Except for the following findings, general physical examination showed nothing abnormal. The mouth showed advanced pyorrhoea and numerous decayed teeth, and the tonsils were enlarged and hyperemic. The tympanic membranes were perforated, and there was scanty, purulent discharge in both auditory canals.

The cranial nerves showed no abnormality. Motor power, sensation and reflexes were normal in the arms. The abdominal and cremaster reflexes were present. There was no motor loss in the abdominal muscles and sensation was normal down to the first lumbar segment. The vesical and anal sphincters functioned normally.

films showed that it was held up just above the lower margin of the body of the second lumbar vertebra (Fig 3), and that no lipiodol had passed this point after twenty-four hours. In contrast to the concave cap usually seen above an intradural tumor, the lower margin of the lipiodol showed a convexity in the posterior projection (Fig 4), which led to a pre-operative diagnosis of possible extradural tumor.

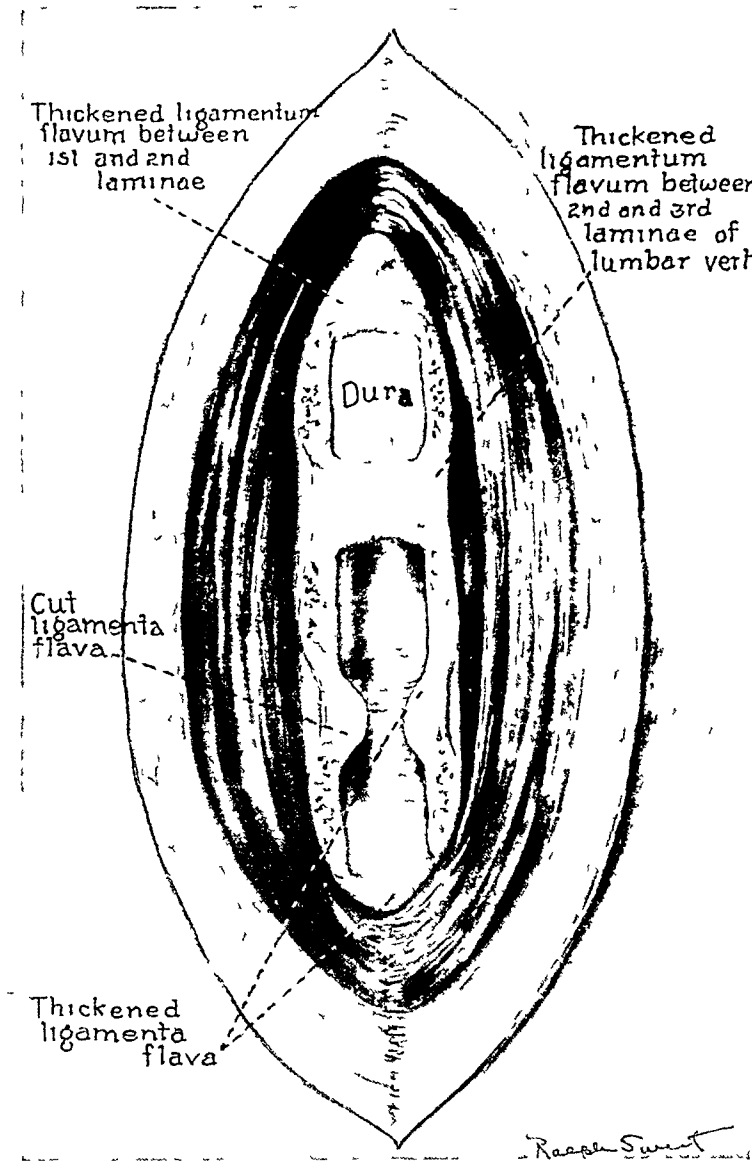


FIG 5—Case I. Diagrammatic sketch of the thickened ligamenta flava which compressed the roots of the spinal cord, as exposed by laminectomy.

*Operation*—November 14. A laminectomy was done on second, third and fourth lumbar vertebrae. After excision of the spinous processes, dense masses of fibrous tissue bulged up between the exposed laminae. These masses were not disturbed, though they made removal of the laminae unusually difficult. The picture after laminectomy is shown semidiagrammatically in Fig 5. There was no epidural fat, and the dura was so thin that it was almost transparent. The dura opposite the second lumbar laminae was bulging.

of the fibrous tissue was made up of elastic fibrils, as demonstrated by sections stained by Unna's orcein method (Fig 7), in which the rather broad, wavy fibrils were stained a light brown color

CASE II—(F L Reichert) *Compression of the cauda equina by thickened and partly calcified ligamenta flava, causing flaccid paraplegia. Rapid improvement after removal of thickened ligaments*

Mrs C E, an American housewife, aged thirty-two years, was admitted to Lane Hospital August 24, 1930, complaining of pain in the back and legs, and of inability to walk

*Past History*—There had been no previous illnesses except measles and mumps, acute otitis media at the age of twelve years, and headaches with nausea and vomiting



FIG 8

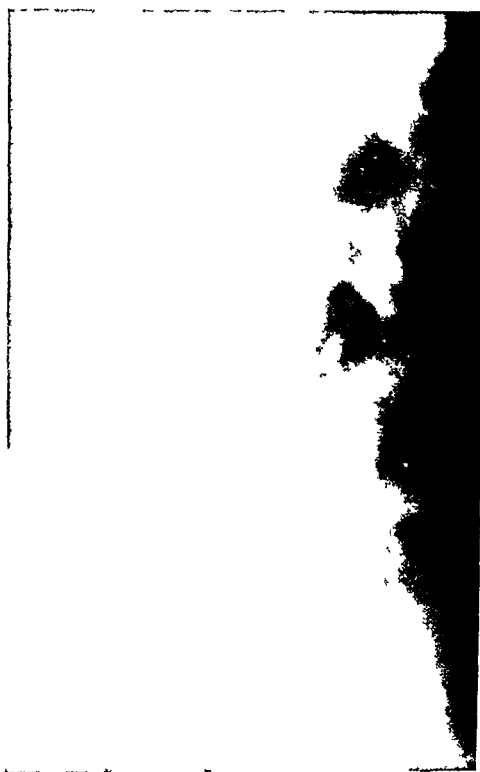


FIG 9

FIG 8—Case II Rontgenogram showing blockade of lipiodol at the fourth lumbar vertebra  
FIG 9—Case II Rontgenogram showing the tapered outline of the lipiodol at the level of the lower third of the fourth lumbar vertebra

once or twice a month since the age of fourteen years. There was no history of injury to the back. She had been married thirteen years, and had one child, aged twelve years. There had been no further pregnancies.

*Present Illness*—She had always had a "weak back" with occasional backaches. Seven years previous she had had an attack of severe pain in the lower lumbar spine, with weakness of the legs. It was difficult to arise from a chair and to walk, and she stayed in bed for a month. Three similar attacks incapacitated her, four to eight weeks at a time during the next six years. Between attacks the legs were practically normal, but she always suffered with backache when fatigued. The fifth attack began in October, 1929, ten months before admission with pain in the lumbar spine, followed shortly thereafter by pain down the right thigh and leg, and weakness of the right lower extrem-

ity After some weeks the left lower extremity was similarly involved In January, 1930, she became bed-ridden In April, 1930, she noticed numbness of the feet and legs In July, six weeks before admission, the lower extremities had lost practically all motion, and she began to have difficulty in voiding, which gradually progressed to complete retention one week before admission

*Physical Examination*—A well-developed, rather obese woman lying on her right side with hips and knees flexed Temperature was 98.8°, pulse rate 80, respiratory rate 20, blood pressure 140/92 The cranial nerves were negative, and motor power, sensation and reflexes were normal in the upper extremities There was pain on pressure over the lower lumbar spinous processes The bladder was distended, and the tone of the anal sphincter was poor

Fibrillary twitchings were seen in the muscles of the lower extremities, and there was muscular atrophy, more marked on the left Resistance to movements of both lower extremities was hardly perceptible All muscle groups were flaccid and weak, with very slight voluntary motion at all joints The patient cooperated poorly in the examination of sensation, so that, although she complained of subjective numbness of the legs and feet, it was possible to map out only a partial saddle anaesthesia The patellar reflexes were active and equal The Achilles reflexes were absent The plantar reflexes were normal

Rontgenograms of the lumbosacral spine were normal Spinal puncture in the third interspace gave no fluid The fluid obtained from the second interspace was slightly bloody, pressure 18 centimetres of water Queckenstedt's test was negative Wassermann reaction was negative, colloidal gold (22 23 21 10 00) August 29, lipiodol was introduced into the subarachnoid space at the cisterna magna, and the films showed that it stopped at the level of the fourth lumbar vertebra, (Fig 8), and that no lipiodol had passed this point three days later In the lateral projection (Fig 9), the lower margin of the lipiodol formed a sharp point at the level of the lower third of the body of the fourth lumbar vertebra The patient was transferred to the surgical service with the diagnosis of tumor of the cauda equina

*Operation*—September 4 A laminectomy was done on the third, fourth and fifth lumbar, and part of the first sacral vertebrae The normal epidural fat was not encountered when the arches of these vertebrae were removed A thick, longitudinal ligamentous structure surrounded the dura and compressed it, as shown diagrammatically in Fig 10 When the posterior portion of the ligament was removed, it was seen that the underlying dura, considerably thinned, was further constricted in the spaces between the laminae by localized thickenings in the ligamentous structure (Fig 11) In the fourth and fifth interspaces, a ring of bone was incorporated in the thickened ligament Beneath the ring of ligament and bone at the fourth interspace, there was a fibrous band which further constricted the dura This was the site of the block in the cerebrospinal fluid circulation, as shown by the absence of pulsation below the fourth interspace The inner surface of the ligamentous structure was smooth and glistening and was not attached to the dura After removal of all constricting tissue, the dural sac resumed its normal size, and pulsations appeared below the fourth interspace Exploration above the third lumbar and below the first sacral laminae showed that a dural sac of normal size was covered with epidural fat The dura was not opened, and the wound was closed in layers

On the seventh day after operation there was considerably improved motor power in the lower extremities On the twenty-first day the patient could stand on her legs and walk with support She began to void spontaneously on the seventeenth day When she was dismissed, on the twenty-fourth day, the saddle anaesthesia was unchanged She reported for reexamination January 6, 1931, four months after operation She was able to walk without a cane Motions of the right ankle and toes were not as strong as those of the left Sacral anaesthesia was still present on the right, but was now absent on the left, except in the fourth and fifth sacral segments There was no disturbance of the



probably the oldest portions of the hypertrophied ligaments. None of the sections showed either tumor formation or inflammatory process.

The etiology of the condition is obscure. The first patient gave a history of a supposed chancre, but the Wassermann reactions on the blood and spinal fluid were negative. In the second case, there was no history of syphilis, and the Wassermann reactions were negative. The first patient had many foci of infection in the teeth, tonsils and middle ears, and he had an advanced osteoarthritis of the spine, but the second was free from obvious foci, and the roentgenograms of her spine showed only a few hypertrophic fringes in the lumbar vertebræ. Certainly the condition here described is in no way analogous to the compression of the spinal cord and its roots by osteoarthritis as described by Bailey and Casamajor<sup>1</sup>. Neither patient gave a history of trauma to the back and although the first, being a laboring man, may well have had repeated mild injuries, the second patient at the time of onset of symptoms was a woman twenty-five years old, in whom unrecognized trauma seems most unlikely.

The diagnosis of compression of the cauda equina was made without difficulty on the history and physical findings in each case. The lipiodol examinations offered a suggestion, in the shape and position of the shadows, that the lesion might be extradural, but there was no pre-operative suspicion of the true character of the lesion. The history of the second patient was unusual in that she had passed through four transient attacks of paraplegia before the final one which did not clear up. The first of these episodes occurred seven years before she came under observation, and the lower extremities were apparently normal between attacks. It is interesting to speculate whether the elastic tissue of the thickened ligaments may explain the long remissions, and whether the first patient might have had a similar course if he had not been operated on during his first attack, before both lower extremities were involved.

*Summary*—A new cause of compression of the lumbosacral roots of the spinal cord is reported, with two illustrative case histories. The condition is a proliferation of the ligamenta flava between laminae of the lumbar spine, which eventually causes a block in the cerebrospinal fluid circulation and compression of the cauda equina. The etiology is unknown. The pathological process is a simple hypertrophy of the ligamenta flava. Extradural compression may be suspected from the position and shape of the lipiodol shadows. The symptoms of compression of the cauda equina were cured by surgical removal of the thickened ligaments.

#### REFERENCE

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roots may be fractured, or teeth may be broken off. There is usually more or less displacement of the fragment, with mal-occlusion of the teeth, and gentle manipulation of the teeth will reveal mobility of the loosened fragment. The X-ray is useful in indicating the extent of the fracture, and also involvement of tooth roots.

*Treatment*—Any hopelessly detached and fractured teeth and roots should be removed. If the fragment of alveolar process is covered by and attached to overlying gum tissue, it is often possible to obtain union by a half-round arch wire fastened to teeth in the fragment and to those of the sound portion of the jaw, or the teeth in a sound portion of the maxilla can be fixed in occlusion with corresponding mandibular teeth by means of wires. If the fragment is exposed by detachment of overlying soft tissue, it is generally

necessary to remove it as necrosis will almost certainly occur. The technic of application of ligature wires and arches to the teeth is the same as for fixation of fractures of the mandible and has been fully described in previous papers.<sup>5</sup>

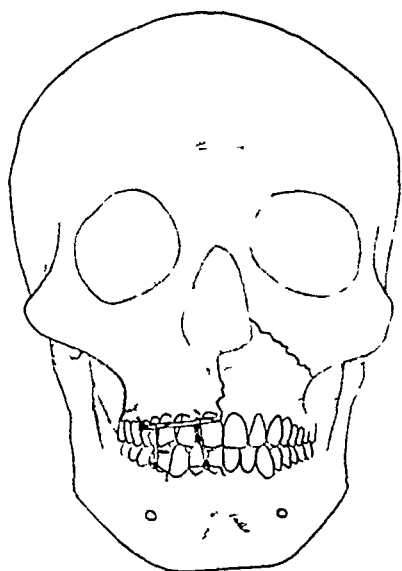


FIG 3



FIG 4

FIG 3—Treatment of unilateral fracture of maxilla by wiring maxillary and mandibular teeth on sound side

FIG 4—Fracture through median palatal suture. Two sides brought together by elastic force across palate

(2) Unilateral fracture of the maxilla is usually caused by direct force coming from in front or from one side. In addition to the symptoms of contusion of the side of the face, the entire maxillary dental arch on the side affected is usually depressed (Fig 1), and may be forced inward, causing a thickening of the palate due to overlapping at the palatine suture (Fig 2). Occasionally, the fragment will be forced outward, causing a spreading of the dental arch on that side. By gentle manipulation, mobility of the fragment can be readily detected. X-ray examination is useful in determining the extent of the fracture, relationship of teeth, etc. The maxillary sinus may be filled with blood clot which usually undergoes absorption or disintegration without symptoms, but which may become infected.

bars emerge at the corners of the mouth and curve back for a distance over the cheeks. A plaster-of-Paris skull cap is made, in which are embedded strips or hooks which can be connected with the bars emerging from the mouth to make traction in the desired direction. When reduction has been attained, as determined by the relationship of the lower to the upper teeth, the latter are fastened in occlusion with wires until consolidation is complete. We have had useful service in cases of this kind from an emergency apparatus consisting essentially of a metal impression tray to which heavy wire arms are soldered on each side for attachment to the head cap (Fig 6). This tray is secured to the teeth by dental impression compound and two or three ligature wires, thus avoiding the necessity of taking impressions and making special splints. Another emergency apparatus consists of a heavy arch bar to be secured to the vestibular surfaces of the teeth with wire ligatures and provided with arms extending out of the mouth on each side for attachment to the head cap (Fig 7). This and the apparatus shown in Fig 6 were made by

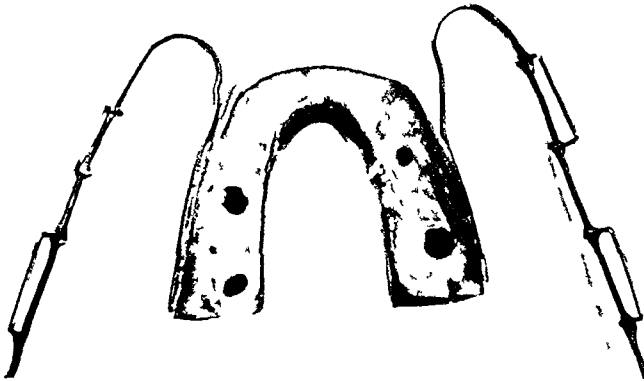


FIG 6

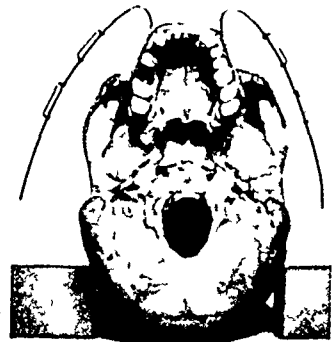


FIG 7

FIG 6—Metal tray with arms extending out of mouth for attachment to head cap (Made by Dr E Howell Smith)

FIG 7—Author's arch bar secured to teeth by wire ligatures for treatment of fracture of maxilla in connection with head cap (Made by Dr E Howell Smith)

Dr E Howell Smith. They can be made in two or three sizes and kept on hand so as to be immediately applicable in any case when the need arises. Where these cases are complicated by fracture through the hard palate, additional measures must be taken to correct the lateral displacement as described under Group I. About six weeks is the average time for union to take place in these fractures.

The following case illustrates the application of these principles.

M. D., female, aged twenty-one, single, was struck down by an automobile while walking across the street, being rendered unconscious by head injuries. She received emergency treatment at St Luke's Hospital, Bethlehem, Pa., by Dr W. D. Chase. Three days later she was brought to the Graduate Hospital, Philadelphia. Here, the patient's face was found to be greatly swollen and battered, the eyelids being practically closed. There was a deep transverse gash across the bridge of the nose with wide separation of its edges. The nasal bones had been detached from the frontal bone above and driven over with the nasal process of the right maxilla into the right orbit, with extensive comminution. The nasal articulation of the frontal bone was exposed in the wound. The external

part of the nose below the wound was sagging downward and in a flattened condition due to lateral displacement of the septum. The patient complained of mal-occlusion of the teeth and examination showed the entire maxillary dental arch to be displaced somewhat backward and downward and slightly movable as a whole. This indicated a bilateral transverse fracture of the maxilla.

Very little suppuration was present in the nasal wound, the temperature was slightly elevated, and the general condition of the patient was good. Owing to the severity and extent of the injury it was considered advisable first to attempt correction of the displacement of the bones about the nasal wound, under ether anesthesia. It was necessary to remove some of the comminuted nasal-bone fragments. The portion which, together with the nasal process of the maxilla had been driven into the right orbit could be lifted over into fairly good position, but difficulty was experienced in retaining it, so that the plan advocated by Blair<sup>1</sup> (Fig 8) was employed. A small incision was made just mesially to and below the inner canthus of the right eye exposing the loose bone fragment. A piece of soft brass wire, 24 gauge, was carried down through the incision by means of a heavy curved needle, across the nasal cavity, transfixing the cartilaginous septum, to emerge through the mucous membrane of the vestibule of the opposite side of the mouth. The other end of the wire was then threaded through the needle and passed around the



FIG 10



FIG 11

FIG 10—Bilateral horizontal fracture of maxilla. Profile view with apparatus in place.  
FIG 11—Skull showing principal sites of fracture of maxilla bone: (1) Zygoma, (2) Infra orbital foramen region, (3) Frontal process, (4) Maxillo-malar articulation.

loose bone fragment, being in turn brought down in the same manner into the vestibule of the mouth. The displaced bone fragment was then firmly anchored in position by attaching the ends of the wire to the canine and first pre-molar teeth of the left maxilla (Fig 9). The retracted edges of the irregular skin wound were undermined and almost completely approximated by sutures. Vaseline gauze packs were inserted into each nasal chamber for twenty-four hours. The complication chiefly to be feared was meningitis, but the temperature returned to normal after three days, both the accidental wound and the small operative incision healed satisfactorily, and the swelling of the soft tissues gradually subsided. Five days later, attention was given to the maxillary fracture. The heavy wire-arch appliance shown in Fig 7 was ligated to the upper teeth, and a plaster head cap was applied. With light leather straps traction was then made possible on the maxilla (Fig 10), and in a few days the normal occlusion of the teeth was re-established. Sufficient stability of the upper jaw was noted after three weeks and the appliances were removed. Six weeks after insertion the brass wire around the nasal fragment was removed under local anesthesia. Respiration through the nose was found to be free, and the scar of the accidental wound was becoming much less noticeable. Later improvement in the nasal profile is contemplated by implantation of costal cartilage.

Occasionally, the injury is limited to the zygomatic arch, there being two lines of fracture in the arch, with a depressed fragment between. This causes a visible and palpable hollow in front of the ear, crepitus may be present, and there is usually interference with the movements of the mandible from pressure on the underlying temporal muscle and coronoid process. In an old case of this kind, seen by us, mal-union resulted in fixation of the lower jaw due to callous and fibrous adhesions connecting the depressed zygomatic arch with the coronoid process.

*X-ray Diagnosis*—The usual positions for obtaining roentgenographic films to show fracture lines and depressions of the bone in this region frequently give unsatisfactory results. The technic suggested by Stone in the



FIG 12

FIG 13

FIG 12—Depressed fracture of right malar bone

FIG 13—Rontgenogram showing depressed fracture of right malar bone

paper quoted is, in his opinion, superior to any previously used. A superoinferior view of the skull is made by having the patient rest the chin on the edge of the table, the tube being beneath the table and the plate on top of the head. Fig 13 gives a good view of a depressed fracture of the right malar bone.

*Treatment*—Depressed fracture of the body of the malar bone. This consists in elevating the depressed bone to its normal position as soon after injury as possible. When this is attempted during the first few days replacement is usually easy, but if the impaction is allowed to remain undisturbed for two weeks or longer it may be extremely difficult to move the displaced fragment and to retain it in normal position.

The means suggested for elevating the depressed malar bone have been many, including digital manipulation from within the mouth, the use of hooked forceps passed through the skin (Gill<sup>3</sup>), hooks and elevators applied through external incisions, and elevation by means of a heavy sound passed into the maxillary sinus through the canine fossa (Lothrop) or through an intranasal window (Shea<sup>9</sup>). None of these methods has seemed to be entirely satisfactory in our hands, either because of inadequacy or on account of unnecessary scarring or danger of infection. In our experience one of the most satisfac-

on the surface of the temporal muscle until it lies deep to the displaced bone. When the lever is inserted in the correct fascial plane it slips under the depressed bone in a most convincing manner, while the operator's hand rests on the firm support given by the skull. The latter should be protected from local pressure injury by a large gauze pad. By careful levering movements the whole bony mass is elevated into correct position, a finger on the various points of fracture is used as a guide to determine when this result has been achieved. In old neglected cases it is often necessary to cut down on individual points of fracture before the bone can be satisfactorily freed, the lines of incision required for this are frequently decided by scars already present. In most cases, however, it is possible to refracture at these points by means of a chisel or osteotome driven into the lines of fracture from the temporal incision. The temporal incision is closed in the usual way, and no drainage is necessary."

We have employed Gillies' method in three cases with very satisfactory results.

For depressed fracture limited to the zygomatic arch, the method of Matas<sup>7</sup> is most efficacious. A heavy curved needle is passed through the skin from above downward beneath the depressed fragment to emerge below the arch. This needle is threaded with heavy silk, which, in turn, serves as a carrier for a piece of silver wire. The two ends of the wire are twisted together and afford a means of traction on the bone fragment whereby it is elevated into position. In case of tendency to recurrence, the wire is twisted over an ordinary glass microscopic slide whose ends rest on the firm portions of the bone. In old cases, where adhesions and callus formation have bound down the depressed fragment to the underlying coronoid process, limiting the movements of the mandible, an open operation becomes necessary to free the latter.

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mucosa, further aggravating the tympanites by disturbing the normal gaseous exchange (4) This distention acts to lessen absorption of gases by impairing the mesenteric circulation on the venous side and, in addition, diffusion of gases from the blood into the bowel lumen is much increased

As distention increases the pendulum movements of the gut stop first, then the rhythmic contractions and the true peristaltic waves last When the pressure within the intestine equals the venous pressure, necrosis results

(5) The partial ileus resultant from these factors in some manner, probably through circulatory disturbance in the intestinal wall, brings about the elaboration of a specific toxin which reduces the contractility of smooth muscle and has a paralyzing action on Auerbach's plexus, similar to that of nicotine when painted on the peritoneum of the experimental animal

This last action completes the picture of complete motor inhibition or paralytic ileus, the result being a functional obstruction as dire in its consequences as that produced by organic obstruction

That obstruction can occur without any narrowing of the lumen at all can be shown by an experiment of Alvarez',<sup>1</sup> which we have repeated The abdomen of a rabbit is opened under normal saline and the intestine clamped with a hemostat and released so as to bruise a ring of gut The abdomen is closed and opened several hours later, when we observe the interesting fact that no food has passed the site of injury Although ample peristaltic waves pass downward, they are seen to break up on approaching the ring of injured tissue The proximal loops are found distended with gas

*Nature of the Toxæmia*—As regards toxæmia, we believe that gastrointestinal obstructions of both the functional and organic types should be divided into two main groups (1) Simple obstructions or occlusions, and (2) obstructions complicated by circulatory insufficiency of the bowel wall

In the first group there is no true toxæmia These patients suffer from dehydration, upset acid-base balance and disturbance of ionic equilibrium as a result of lost electrolytes These three conditions are all due to loss of digestive secretions through vomiting

Whether an acidosis or alkalosis develops depends on the relative amounts lost of the acid gastric juice as compared to the alkaline bile, pancreatic and intestinal secretions

We must remember, too, that many of these patients only "vomit" as far as their stomachs Lavage may show marked retention from gastric dilatation and these secretions are lost to the body as no absorption takes place from the stomach Obviously in this first group the symptoms will be more severe the higher the obstruction

In the second group of cases one may have the foregoing problems to deal with, and, in addition, a true toxæmia

The many theories regarding the nature of this toxæmia will not be gone into here Suffice it to say, however, that our personal opinion is that a specific toxic substance is formed as a result of local circulatory deficiency

We believe this toxin is elaborated in the mucosa of the greater part of

treated these peritonitic patients primarily as cases of obstruction, we would effect a great reduction in our mortality rates

In the treatment of peritonitis it is not sufficient to return the patient to bed from the operating table, there to be placed in the Fowler position with an ice-bag on the abdomen and an order for 2 per cent soda and 5 per cent glucose by proctoclysis. Such therapy has long proved itself inadequate

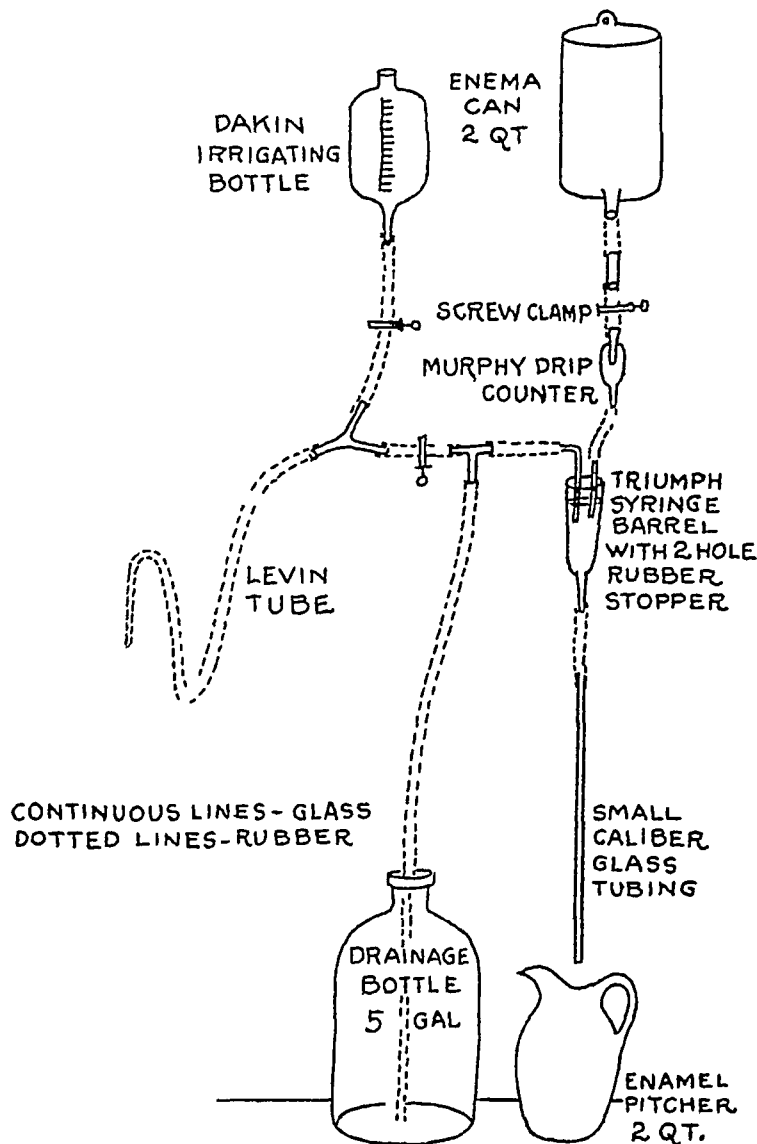


FIG 1—Connell apparatus as set up in Hollywood Hospital by Gurn Stout M D

While there should be no such thing as a routine treatment in medicine, it is, however, advisable to have a campaign of action in mind, otherwise our efforts are apt to be so dispersed as to be of little value

For these obstructive cases we would consider the following treatment appropriate



tone grams, 50, water 1 liter Calcium caseinate grams, 25, is added to the above if bowels are loose From two to four ounces is given through the tube every two hours

(c) After the patient has rounded the turn in the road to better health, a greater amount of nourishment can be given through the tube if it proves necessary and desirable In this case we add the following to furnish fats and vitamins, 20 per cent cream 180 cubic centimetres, egg yolk 2, olive oil 15 cubic centimetres, cod-liver oil 15 centimetres, malt extract with iron 1 tablespoon This formula is given in twelve feedings Orange juice is given by mouth

With the above formula it is possible to give the patient a four and one-half ounce, well-balanced meal every two hours providing the essential vitamins and a caloric intake of 2575, sufficient for an average-sized man doing a good day's work

No catharsis is attempted and no effort is made to stimulate peristalsis directly

The successful use of this treatment requires a full knowledge of the principles involved and careful attention to details

*Comment*—Many operators have reported a reduction in their mortality rate by use of early jejunostomy The common practice, however, is to resort to the operation only as a last resort

The use of such an apparatus as described for continuous gastric and duodenal drainage will accomplish all that a jejunostomy will and more It can be utilized early, the patient is not subjected to the risk of a secondary operation, there is no fistula to contend with, the apparatus is under perfect control at all times and is born by the patient with but slight discomfort If the tube should be removed prematurely, patients will often ask for its replacement because of the comfort afforded The apparatus should be kept in use until all danger from intestinal paresis is past

This apparatus removes a considerable part of the toxic-bowel content and also provides a ready means of placing hypertonic saline directly into the upper intestine, where theoretically it might accomplish the most good

One criticism that has been directed against duodenal drainage is that it removes more fluids than are given orally While this is true early in treatment, there is a gradual reversal as the patient's condition improves It is the parenteral injections of saline that are relied on to relieve anhydiæmia rather than fluids given through the tube

The lack of food during the first week produces a mild acidosis that takes care of the initial alkalosis These patients readily develop acidosis of a marked degree and for this reason we feel that the use of hydrochloric acid is inadvisable and unnecessary

Sodium-chloride solutions injected intravenously will augment peristalsis This interesting fact was discovered by Hughson and Scarff,<sup>4</sup> while experimenting with the isolated segment of intestine in cats

# APPLICATION AND INTERPRETATION OF BLOOD SUGAR TIME CURVES IN THE DIAGNOSIS AND TREATMENT OF SURGICAL INFECTIONS OF THE GALL-BLADDER AND BILIARY PASSAGES

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THE use of blood sugar time curves as an aid in the diagnosis, and as a guide to the extent of operative treatment, of infection of the gall-bladder and the biliary passages has been a routine in this hospital for a number of years and some of the results have been referred to previously<sup>1 2 3</sup>. As an adjunct to the diagnosis of cholecystitis, these curves were regarded as the most reliable of all laboratory tests then made use of. Other tests included (a) single estimation of blood sugar in the fasting state, (b) the van den Bergh reaction, (c) quantitative determination of urine urobilinogen, (d) fat partition of faeces and (e) X-ray visualization of the gall-bladder. In a more recent report,<sup>4</sup> Ritchie and Rabinowitch have shown, with regard to the combined use of X-rays and blood sugar time curves, that diagnosis was practically certain for or against when agreement was found between the results of these two tests. The number of cases then reported was small, but the data suggested, providing the tests were properly applied and interpreted, that a very satisfactory state had been reached with respect to diagnosis. The purpose of the present report is to demonstrate the value of blood sugar time curves as an indication of the extent of surgical treatment demanded and a guide to the post-operative progress of the patient.

As with all laboratory procedures, proper application and interpretation of tests made use of in the study of biliary disease depend upon proper appreciation of the physiological principles upon which each test is based. For example, X-rays may indicate disease of the gall-bladder directly, whereas the blood sugar time curve affords indirect evidence only, the type of curve obtained depending upon the presence or absence of an associated pancreatitis.

Though referred to in previous publications of this hospital, a brief outline may here be given of the factors which must be considered when blood sugar time curves are used in the study of disease of the biliary passages. In view of the physiological principles upon which the test is based, it is obvious that there are conditions other than disease of the biliary passages which may lead to abnormal curves, as noted in the following observations.

*Principles of the Test*—The response of an individual to glucose ingestion depends essentially upon (a) the rate at which the ingested glucose is absorbed from the alimentary canal and (b) the rate at which the absorbed glucose is utilized. (By utilization is meant the combined mechanisms of oxidation and storage.) If either oxidation or storage be faulty, the rate

Incidentally, at each visit to the patient, the metabolism nurse makes careful note of any possible mishap during the test (loss of urine, accidental ingestion of other food or fluids, etc.)

Of course, all tests are commenced in the morning in the fasting state, at least twelve to fifteen hours after the evening meal of the preceding day. Judging from the literature the practice of testing the effects of glucose administration during the day after an ordinary meal is not uncommon. An important fact to consider with such a practice is that ingestion of sugar in any form stimulates the mechanism of its utilization and the effects upon the blood content of administration of a second dose may not be as marked. Blood sugar time curves obtained with repeated doses of glucose strikingly demonstrate this phenomenon.<sup>7, 8</sup> A brief description may here be given of what, in our opinion, constitutes a normal curve, as there is some disagreement amongst workers in this field.

*Attributes of blood sugar time curves*—There is general agreement as to the normal content of the blood sugar in the fasting state that is, before any glucose is given, it ranges between 0.08 and 0.12 per cent. It is also agreed that the blood sugar should return to normal two hours after the glucose is given. As a matter of fact, the above information, probably because of the general agreement, is all that is required by some life assurance companies, when glycosuria is discovered in an applicant. The two other attributes of the curve, with regard to which there is disagreement are (a) the "peak", that is, the maximum height which the blood sugar reaches sometime during the test, and (b) the "lag", that is, at times, instead of the blood sugar rising rapidly and reaching its maximum at the thirty minute period, it may rise gradually and reach the peak at the sixty minute period or later. Based upon experience of over 4000 curves all obtained with the same type sugar the same amount sugar and the same technic of blood sugar estimation, based also upon correlation of clinical with laboratory data, it is our opinion that both the "peak" and the "lag" are important attributes to consider. A curve, in our opinion, is, therefore regarded as normal only when

(a) The blood sugar in the fasting state (before glucose) is normal (0.08 to 0.120 per cent.)

(b) After glucose, the maximum blood sugar ("peak") is not greater than 0.180 per cent.

(c) The "peak" occurs at the thirty minute period.

(d) The blood sugar is again normal, or below, at the 120 minute period, that is, two hours after the glucose is given.

*Methods of estimating blood sugar*—With regard to interpretation, an important consideration is the use of different methods of blood sugar estimations. The values obtained with the different methods differ, and the newer methods give lower blood sugar values than the older procedures. For our routine work we still adhere to a slightly modified form of the Myers-Benedict procedure. This test has received much criticism and the general tendency is to discredit it. The following observations may, therefore, be made

peated that we are quite in agreement with Benedict in his assertion that rarely has the clinician been misled by the data obtained with this method of blood sugar estimation. We have frequently noted the fact, mentioned by Benedict<sup>8</sup> that blood sugar, by this method, parallels the clinical progress of the diabetic more closely than the results of Folin-Wu method, with which a decline in blood sugar concentrations is found to be more rapid. It may here be observed that all new methods as they appear in the literature, are given a fair trial, from point of view of accuracy and practicability.

Having performed the test with careful attention to all details and having excluded the many conditions other than pancreatitis which may lead to abnormal curves, there remains one condition which may be dealt with separately, but is commonly associated with cholelithiasis and cholecystitis and not always readily recognized clinically, namely, hepatitis. Hepatitis may, *per se*, be responsible for defective storage of glucose, and with such defective storage, the blood sugar time curve may be identical with that seen in pancreatitis. The effects of hepatitis may be, however, fairly readily measured by the combined use of the van den Bergh reaction for bilirubin in blood and the test for urobilinogen in urine. By correlating our data, we have only rarely been able to attribute an abnormal blood sugar time curve to hepatitis, when the blood showed less than 0.5 milligrams of bilirubin per 100 cubic centimetres (van den Bergh equals 1 unit), or when urobilinogen was present in urine in less than 1 in 50 dilution, according to the Wallace and Diamond technic.<sup>9</sup>

The use of blood sugar time curves as an index of treatment and progress of disease of the gall-bladder and its passages will now be outlined.

As stated above, the test affords indirect evidence of disease of the gall-bladder, it depends upon the presence or absence of pancreatitis, and our use of the test as an index of treatment and progress depends upon the assumption that the course of an individual suffering from pancreatitis is somewhat similar to that noted in partially depancreatized animals. For example, Allen<sup>10</sup> has clearly shown that it is possible to remove, within certain limits, pancreatic tissue from the dog without the production of diabetes, the animal may develop glycosuria, but, if properly dieted, the glycosuria disappears and the animal does not subsequently develop diabetes. It is suggested that the latter condition is somewhat similar to the mild and temporary hyperglycæmia and glycosuria occasionally seen in man with disease of the biliary passages complicated by pancreatitis. With adequate surgical treatment of the biliary disturbance and dieting, the hyperglycæmia and glycosuria disappear and the individual does not subsequently develop diabetes. With inadequate or delayed treatment, however, the pancreatitis becomes chronic and as the disease progresses, with loss of more and more pancreatic tissue, the individual subsequently develops diabetes. The following curves taken from many hundreds are cited as representative of possible courses of events in patients treated for cholecystitis and cholelithiasis (*a*) by operation with and without special diets, and (*b*) without operation with and without special diets.

suggests a remarkably efficient mechanism of utilization of carbohydrates. In the other case (2700/29), two abnormalities are still present, namely, (a) a blood sugar on the borderline of hyperglycemia in the fasting state, and (b) a maximum blood sugar of 0.200 per cent.

The most ideal results were obtained when operation was not delayed and in addition to operation, the patients were assumed to be diabetic for the time being and dieted accordingly. The following is a representative sample.

			Blood sugar (per cent)				
Date			Fast- ing	30 min	60 min	120 min	150 min
Hosp No 2101/29	April	16/29	0.128	0.212	0.312	0.295	0.285
	September	2/30	0.111	0.151	0.166	0.090	0.112

It will be noted that, in spite of slight hyperglycemia in the fasting state, a "lag" and marked hyperglycemia throughout the test, the curve is normal seventeen months later, except for the slight "lag."

As stated before, very little attention had been paid by some other observers to the "lag." By following the practice of some insurance companies who request only the blood sugar in the fasting state and again two hours after glucose ingestion, not only is the "lag" not detected, but the "peak" of the curve may also be missed, since, in mild disturbances of carbohydrate metabolism, the "peak" as in the normal curve, may be reached at the thirty minute period. The following case is an example.

			Blood sugar (per cent)				
Date			Fast- ing	30 min	60 min	120 min	150 min
Hosp No 2159/30	April	22/30	0.120	0.200	0.137	0.112	0.117
	December	5/30	0.107	0.178	0.185	0.161	0.123

In this case there was a definite diagnosis of pancreatitis. The "peak" was, however, the only indication of abnormal carbohydrate metabolism. The blood sugar of the fasting period and two hours after glucose ingestion would have alone yielded little information. Further suggestive evidence that the carbohydrate metabolism was not normal in this case are the characteristics of the curve obtained after operation. It will be noted that there was not only a "lag," but definite hyperglycemia at the two-hour period and a blood sugar on the borderline of hyperglycemia at the end of the test\*.

With regard to fasting blood sugars on the borderline of normality, it here may be observed that, when correlated with time curves, the majority are abnormal.

The combined effects of delayed operation and irregular diet, in spite of persistence of signs and symptoms of fairly active disease are shown in the following case. The diagnosis of cholelithiasis was made in May, 1929. The patient refused operation and followed diet irregularly. In August, the same year, because she was told the results of the test were identical with those of diabetes, she commenced to follow diet more rigidly. There was temporary improvement of carbohydrate tolerance as shown by the curve obtained in April, 1930. In August of the same year, however, the curve suggested downward progress. In fact, the carbohydrate metabolism was more disturbed than when the patient was first seen. She has since been operated upon.

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\*Failure to detect the peak of the curve has, frequently, judging from the literature, accounted for a diagnosis of renal glycosuria. The diagnosis in such cases was largely based upon the finding of glycosuria accompanied by blood sugars below the generally accepted renal threshold values. A discussion of this phase of the subject will be found in a recent publication from this hospital<sup>11</sup> on renal glycosuria.

Operation February 28, 1930

April	25/30	0 122	0 222	0 212	0 200	0 181
March	10/31	0 113	0 161	0 166	0 204	0 232

Considering the group as a whole, the general impression gained by us is that an abnormal blood sugar time curve occurring in a patient with infection of the gall-bladder is an indication of an associated pancreatitis, that adequate surgical treatment and prolonged post-operative controlled diet leads to marked improvement in, or return to normal of, the blood sugar time curve, that inadequate surgical treatment, even with similar controlled diet, does not produce the same satisfactory results. One of the writers (A T B) has made it his practice to assume, when the history, physical examination and X-rays indicate disease, and the blood sugar time curve is not disturbed, that the infection is local, *i e*, confined to the gall-bladder, there is no pancreatic involvement. In such cases, in the absence of other indications, the gall-bladder is removed but the common bile duct is not drained. If, however, the blood sugar time curve is abnormal, pancreatitis is assumed and the duct is drained\*. Statistical proof of the correctness of this practice is, however, still lacking, in view of the relatively small amount of material compared with the many other variables, which have to be excluded. The latter include diet before operation, diet after operation, duration of illness, severity of illness, number and severity of acute and subacute attacks of pain, etc. However, on the basis of presently available knowledge, this practice seems justified.

The primary purpose of this communication is to indicate a measure for the prevention of diabetes mellitus. Infections of the gall-bladder and the biliary passages account for a large percentage of adult diabetics. It is our opinion that the routine practice described above and which we are following has not been without success.

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\*An important observation which may here be referred to is the fact that intravenous injection of phenoltetraiodophthalein for X-ray visualization of the gall-bladder may, at times, cause temporary disturbance of liver function (hepatitis), sufficient to interfere with normal storage of glucose as glycogen. Under these conditions, an abnormal blood sugar time curve may be found in the absence of pancreatitis. It is, therefore, important, and it is our routine procedure, to test the sugar tolerance not after, but BEFORE the patient is given the dye for X-ray purposes.

"Bile peritonitis" has been considered by Sellands, Horrall, and Still as a chemical irritation. Horrall noted this condition to be accompanied by vomiting, which was noted in many of Stanton's cases and is a striking characteristic in six reviewed in this report. (This symptom leads to a suspicion of acute gastric dilatation.)

The recent experiments upon "The cause of Death in Liver Autolysis," by Edmund Andrews and Leo Hardina<sup>2</sup> and those of Allan G. Rewbridge<sup>3</sup> entitled "The Etiological Role of Gas-forming Bacilli in Experimental Bile Peritonitis" are noteworthy, but do not explain the cases under consideration.

Stanton contrasts the symptomatology of rupture of the liver and rupture of the spleen and thinks that death following the former and those under discussion have similar operative factors but what they are he does not know.

In a review of recently published reports of liver rupture, the symptomatology has been that of secondary bleeding and not strikingly dissimilar from that of rupture of the spleen.

In personal cases of rupture of the liver this high temperature reaction has been wanting, as it is likewise in Rewbridge's<sup>3</sup> report upon gall-bladder rupture and consequent peritonitis in dogs. His conclusion (which does not necessarily apply to humans) is that *Bacillus welchii* invades the peritoneal cavity presumably as the result of permeability changes produced by the local action of the bile salts.

Such a permeability change, possibly a surface-tension phenomenon, seems quite plausible when one considers the action of the sulphur granules in Hay's test for bile in urine.

A summary of a personal case of rupture of the gall-bladder with recovery follows. A twelve-year-old boy was seen in consultation with Dr. I. E. Ozanne, because of gradually increasing abdominal pain, one week after an auto injury. Examination revealed abdominal distention with shifting dullness, muscle spasm, but not board-like rigidity. The temperature was 98° F, pulse 84, respiration 24. The urine showed albumin, acetone and bile, leucocyte count was 27,000. A diagnosis of rupture of abdominal viscera was made. Under local anaesthesia a mid-line incision was followed by the escape of a large amount of bile-stained fluid. The viscera were bile-stained and oedematous, the gall-bladder ruptured. Abdominal drainage and enterostomy were done.

Twelve hours after operation the temperature went up to 101.2° F, the next day it rose to 104° F with corresponding increase in pulse rate. Thereafter the temperature rapidly declined and the patient made an uneventful recovery.

The vogue of omitting drainage after cholecystectomy has been followed, at times, by bile leakage into the peritoneal cavity, but high-temperature reactions are evidently rare, and secondary operation for drainage is usually followed by recovery.

It would seem that the above possibilities may be quite satisfactorily excluded as causative factors in these high-temperature fatalities. So-called liver "shock" and liver "insufficiency" call for serious consideration.

Cholæmia has been found so often to be in reality an uræmia that the name does not suggest a positive entity.

Of these seventeen cases (23.6 per cent of total number of deaths), the following facts were tabulated <sup>4</sup>

*Pre-operative*—Age incidence Between twenty and thirty years, 3 cases, between thirty and forty years, 3 cases, between forty and fifty years, 3 cases, between fifty and sixty years, 5 cases, between sixty and seventy years, 3 cases Female, 15, male, 2

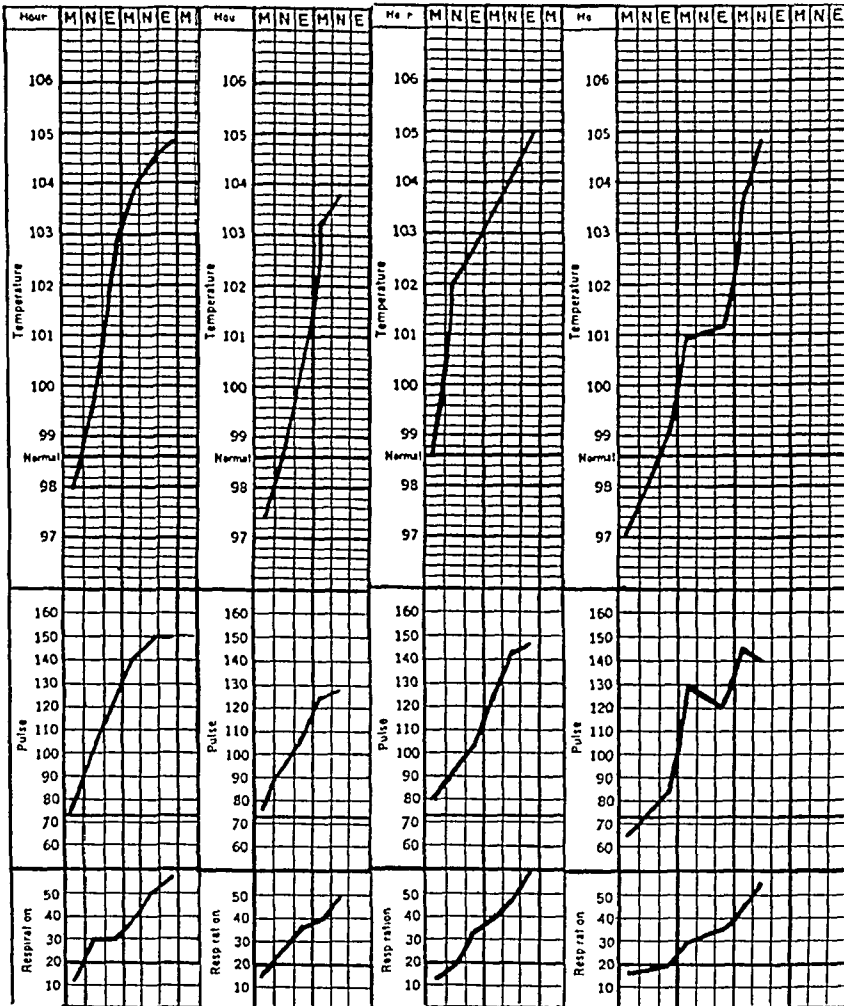


CHART 1 —Post operative temperature charts Typical of group

Obesity, 6  
Jaundice, 6  
Thyroid enlargement, 6  
Pregnancies, 7

*Previous operations*—Two suspension of uterus and one subsequent laparotomy, for adhesions Fibroid of uterus removed Appendectomy and hysterectomy Cholecystostomy twice

\* In the analysis of these case histories I was assisted by Dr May Aileen Davies, of Madison, Wisconsin.



*Treatment*—In the absence of a known etiologic factor, treatment must, of course, be largely symptomatic

In a review of the abortive cases (*i e*, in which symptoms start out similar to the fatal cases but rapidly subside and recovery takes place) the therapeutic attempts differ in no remarkable way from those employed in the less fortunate cases, and include the following measures

Heat to abdomen, light and diathermy, cold ice-bag to head and precordia, rest, bromides, opiates, veratrum viride, gastric lavage, rectal feeding, proctoclysis glucose, malted milk, normal saline, tap water, enteroclysis glucose, normal saline, insulin, intravenous glucose, sodium bicarbonate, normal saline solution, ringer's solution, digifolin—oxygen inhalation

Because of a possible disturbance in the pancreatic function or in the glycogenic function of the liver, glucose, with or without insulin, has been given

In this connection the following instance is of interest Mrs Wm T February 26 1931, the second post-operative day was characterized by marked restlessness, apprehension cyanosis, dyspnoea, vomiting, and temperature  $102.2^{\circ} F$ , pulse 126, respiration 36 Gastric lavage, digifolin and glucose intravenous were ordered, and were followed by rapid subsidence of symptoms and in due time, recovery On the next day it was discovered that, through a misunderstanding, a solution of sodium chloride had been given instead of glucose

#### SUMMARY

1 Rapid high temperature deaths following biliary-tract operation are probably much more frequent than is indicated by the literature

2 Such deaths have been confused with those due to hæmorrhage, shock, cardiovascular, renal disease, hyperthyroidism, pulmonary disease or accident, acute gastric dilatation, septic peritonitis

3 Bile "peritonitis," liver "shock" or liver "insufficiency" have been explained by Diseased or chemically altered liver-cells or bile, changed cholesterol metabolism, protein shock, allergy or anaphylaxis, injury to the nervous mechanism of the liver, or an overwhelming toxæmia, but the signs and symptoms do not coincide with those of the cases under consideration

4 With our present information, this rapid high-temperature death must be looked upon as a chemical or metabolic reaction, the nature of which is unknown

5 In the literature, Stanton was able to collect twenty such cases

6 At the Mercy Hospital (1925-1930) in seventy-two deaths following biliary-tract operation, seventeen (23.6 per cent) could be grouped in this classification

7 Pre-operative diagnoses, in addition to cholecystitis, were Appendicitis, 6, goitre, 1, salpingitis, 1, myocarditis, 2

8 Anæsthesia General, 13, spinal, 2, general and spinal, 1, general, spinal and local, 1

9 Nature of operation Cholecystectomy, 13, cholecystostomy, 4 In addition Choledochostomy in 4, appendectomy in 11, pelvic operation in 1

# CHOLECYSTOSTOMY<sup>1</sup>

WITH SPECIAL REFERENCE TO POST-OPERATIVE MORBIDITY AND FUNCTION

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IN RECENT years surgeons have become more and more inclined to broaden the indications for cholecystectomy, at the expense, so to speak, of operations for drainage of the gall-bladder. The result has been a gradual and definite increase in the percentage of cholecystectomies in operations performed for cholecystitis. Mentzer<sup>1</sup> quotes figures from the Mayo Clinic showing that in 1906, 55.7 per cent of gall-bladder operations were cholecystostomies, in 1926, only 4.3 per cent. Figures vary from different clinics<sup>2, 3</sup> but certainly cholecystostomy is not performed with the same frequency as formerly.

The reason for the change in operative methods is obvious. Recurrence of symptoms sometimes necessitating secondary operation has forced surgical opinion to regard cholecystectomy as the operation of choice. Modern methods of preparation of the patient, newer types of anaesthesia, more thorough training of surgical personnel, and improved after-care of the patient have reduced the dangers from the operation for the removal of the gall-bladder and have made possible the more frequent extirpation of an obviously diseased and functionless viscus, which in earlier years would have been drained.

Although cholecystectomy is the operation of choice in the majority of cases of gall-bladder disease, cholecystostomy still retains a definite place in the list of operations performed for disease of the biliary tract. For this study we have selected the last 100 cases of cholecystostomy performed during the last seven years on Surgical Service C, at the University of Pennsylvania Hospital. In the last year, cholecystostomy has been performed in approximately 18 per cent of the patients suffering from gall-bladder disease. These include all complications, such as pancreatitis, acute cholecystitis and poor surgical risks. When analyzed according to years it was noted that the percentage was much higher in the earlier years (38 per cent), and fell considerably in the later years.

The indications for cholecystostomy may be divided conveniently into three groups. Group 1—Cholecystitis with jaundice, with or without common-duct obstruction. Group 2—Acute cholecystitis. Chronic cholecystitis in poor-risk patients. Group 3—Patients with symptoms of gall-bladder disease, with or without stones, in whom the gall-bladder appears to be a functioning organ.

The first group, comprising patients with cholecystitis and jaundice, is agreed by most surgeons to be an indication for conservation of the gall-

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<sup>1</sup>Read before the Philadelphia Academy of Surgery, April 6, 1931.

cirrhosis, or chronic pancreatitis, most of whom were treated by choledochostomy or choledochotomy in addition to cholecystostomy. There were two operative deaths—18.8 per cent. Eight of the surviving cases have been followed. Three (37.5 per cent) had a return of their previous symptoms requiring operation. In the remaining five patients there has been no return of symptoms in one to four years.

Taking the jaundice group as a whole, the operative mortality was 20.7 per cent, a recurrence of symptoms occurred in 23.4 per cent of the surviving cases, and 76.6 per cent were clinically cured. Of the five cases in whom secondary operations were performed, stones were found in three.

The second group of indications for cholecystostomy includes those cases where acute or chronic cholecystitis is associated with some acute local or chronic systemic disease, in other words, in patients on whom the surgeon is afraid to risk the more difficult and radical operation of cholecystectomy. "It is better, in the occasional case, to perform cholecystostomy with the possibility of having to reoperate, than to risk losing the patient with a more radical operation" (W. J. Mayo).

TABLE II

*Results of Cholecystostomy in Acute and Chronic Cholecystitis without Jaundice*

	Group 2					
	No. of cases	Operative deaths	Return of symptoms	Secondary operations	No symptoms	Not followed
Acute cholecystitis	39	1	7*	2	26†	5
Chronic cholecystitis in poor-risk patients	10		3		5‡	2
	49	1	10	3	31	7

\* Two with carcinoma of biliary tract

† One 1 year, four 2 years, four 3 years, seven 4 years, five 5 years, one 7 years, two died of intercurrent disease

‡ Three 4 years, two died of intercurrent disease

The indications for cholecystostomy are not always clear cut in the cases in this group and often depend upon the experience, judgment and skill of the surgeon and his staff, as well as on the patient's condition. Forty-nine of the cases fall in this group. (See Table II.) The larger part of the group (thirty-nine cases) were patients with acute cholecystitis. In all such cases, when possible, operation is delayed until the acute symptoms subside. When, however, the acute symptoms continue or increase in severity, or when signs appear of extension of the inflammatory process to the pancreas, or when there are symptoms of respiratory or cardiac embarrassment, it has been the practice in this clinic to perform a cholecystostomy even in the acute stage.

Most of these patients were considered poor operative risks for various reasons. Age (five cases) or serious cardiac or pulmonary disease (five cases) were factors in some instances. In the majority of patients (twenty cases) the extent of the local inflammatory process was such that the patient was acutely ill and any but the simplest and shortest operation would have

appears to play an important and direct part in the digestion and absorption of fat, and an indirect one, by influencing pancreatic secretion in the digestion of other food constituents

The gall-bladder plays a fairly important rôle in the physiology of digestion. Its functions, according to modern physiologists,<sup>8</sup> are (a) Storage and concentration of bile during fasting, and (b) emptying of stored bile into the duodenum during digestion especially of fats by muscular action. On the presence of a functioning gall-bladder then, depends in large measure the action of bile in digestion, because the amount which can enter the duodenum from the liver and normal common duct is small in comparison.

These functions of the gall-bladder are of enough importance to warrant its preservation. "The fact that its absence is tolerated," in Wilkie's opinion,<sup>9</sup> "is no argument against the importance of its function, it is merely a tribute to nature's powers of compensation." The compensatory changes which occur following loss of gall-bladder function, either by chronic disease or by cholecystectomy, have been observed by many.<sup>9-10</sup> There is usually a gradual dilatation of the bile-ducts and after cholecystectomy often a dilatation of the stump of the cystic duct to form a new miniature gall-bladder. This is nature's effort to replace the storage function of the gall-bladder. In addition, Sutton<sup>11</sup> has recently shown experimentally that the bile-duct epithelium undergoes changes of adaption to assume the function normally performed by the gall-bladder.

These changes require time, and we have noted that removal of a normal-appearing and supposedly functioning gall-bladder is often followed by a period in which there are nausea and epigastric distress, especially following the ingestion of fatty foods.<sup>4</sup> McKenty<sup>12</sup> has noted that the full benefit of cholecystectomy is sometimes delayed for more than a year after operation—presumably due to the fact that gradual compensatory dilatation of the ducts is necessary before approximately normal function can take place.

In this series, the state of gall-bladder function was judged by two methods

(a) Examination of the gall-bladder at operation

A gall-bladder of translucent, cerulean blue, not indurated, without lymphadenitis or adhesions, with a common duct of normal size, was judged to be a functioning organ, even if it contained one or several stones.

(b) Cholecystographic evidence of gall-bladder function

The Graham-Cole method of testing gall-bladder function determines its ability to concentrate the dye and to empty it in response to a fatty meal—which functions may be normally preserved even in the presence of stones.<sup>13</sup>

In this group are twenty-two cases of our series. (See Table III.) Eight of these gave symptoms of apparent gall-bladder disease, but at operation the gall-bladder appeared normal in color and texture and contained no stones. In two of these the gall-bladder had functioned normally when examined by X-ray and one showed a non-functioning gall-bladder when the dye was given by the oral method. There was one death, one week after

them showed a normally functioning gall-bladder, from twenty-five days to nineteen years after operation, and they concluded that "drainage of a diseased gall-bladder, with the expectation that it will regain its normal function, is not only a futile procedure but one that endangers the future health of the patient"

They have thus answered question two in the negative. Our study was made on twenty patients in a similar manner and with nearly similar results. The dye, sodium tetraiodophenolphthalein, was administered by the oral method in all cases and in a few the findings were confirmed by the intravenous technic\*. Table IV gives a summary of these cases, all of whom had definite disease of the gall-bladder as noted at operation. The first five cases belonged to the group of cholecystitis with jaundice. One of these (Case II) showed a normally functioning gall-bladder two years following cholecystostomy and choledochostomy. The gall-bladder was not visualized in any of the other patients.

TABLE IV

CASE I—Female, aged forty years. Pre-operative X-ray diagnosis—None. Operative diagnosis and findings—Gall-bladder small. Stones in common duct and gall-bladder. Time since gall-bladder drainage—Two years. Post-operative X-ray diagnosis—No visualization of gall-bladder. Symptoms since cholecystostomy—Indigestion only if fatty foods are eaten. Operative findings secondary operation—None.

CASE II—Male, aged fifty-three years. Pre-operative X-ray diagnosis—None. Operative diagnosis and findings—Gall-bladder distended. Stones in gall-bladder and common duct. Time since gall-bladder drainage—Two years. Post-operative X-ray diagnosis—Normally functioning gall-bladder. Symptoms since cholecystostomy—No symptoms. Operative findings secondary operation—None.

CASE III—Female, aged forty-nine years. Pre-operative X-ray diagnosis—Gall-bladder shadow faint. Poor concentration and emptying. Operative diagnosis and findings—Gall-bladder thick. Stones in gall-bladder and common duct. Time since gall-bladder drainage—Two years. Post-operative X-ray diagnosis—Non-functioning gall-bladder. Symptoms since cholecystostomy—Pain in right upper quadrant. Distention. Operative findings secondary operation—Gall-bladder thick. Many stones.

CASE IV—Female, aged forty-two years. Pre-operative X-ray diagnosis—Gall-bladder not visualized. Operative diagnosis and findings—Thick gall-bladder. Many adhesions. No stones. Time since gall-bladder drainage—Four years. Post-operative X-ray diagnosis—No visualization of gall-bladder. Symptoms since cholecystostomy—No symptoms. Small hernia. Operative findings secondary operation—None.

CASE V—Female, aged forty years. Pre-operative X-ray diagnosis—Gall-bladder not visualized. Operative diagnosis and findings—Ulcers of mucosa. Three stones. Time since gall-bladder drainage—One year. Post-operative X-ray diagnosis—No visualization of gall-bladder. Symptoms since cholecystostomy—Slight jaundice. Tenderness over gall-bladder. Operative findings secondary operation—No stones. Gall-bladder thick. Ulcers of mucosa.

CASE VI—Female, aged fifty-six years. Pre-operative X-ray diagnosis—None. Operative diagnosis and findings—Acute cholecystitis. Four large stones. Time since gall-bladder drainage—Six years. Post-operative X-ray diagnosis—No visualization of

\* A personal communication to the authors from Dr. E. P. Pendergrass, of the Rontgen Department, University Hospital, was to the effect that practically as good results have been obtained by the oral as by the intravenous method of giving the dye.

bladder drainage—Four years Post-operative X-ray diagnosis—No visualization of gall-bladder Symptoms since cholecystostomy—Occasional soreness in right upper abdomen Operative findings secondary operation—None

CASE XVIII—Female, aged thirty-one years Pre-operative X-ray diagnosis—Gall-bladder not visualized Operative diagnosis and findings—Gall-bladder contracted Thick Many stones Time since gall-bladder drainage—Two years Post-operative X-ray diagnosis—No visualization of gall-bladder Symptoms since cholecystostomy—No symptoms Operative findings secondary operation—None

CASE XIX—Male, aged forty-five years Pre-operative X-ray diagnosis—None Operative diagnosis and findings—Thick oedematous gall-bladder One stone Time since gall-bladder drainage—Five years Post-operative X-ray diagnosis—Faint shadow Impaired function Symptoms since cholecystostomy—No symptoms Small hernia Operative findings secondary operation—None

CASE XX—Female, aged forty-six years Non-functioning gall-bladder Operative diagnosis and findings—Gall-bladder thick No stone Time since gall-bladder drainage—Five years Post-operative X-ray diagnosis—No visualization Symptoms since cholecystostomy—No symptoms Operative findings secondary operation—None

Cases VI to XV represent patients with acute or chronic gall-bladder disease, who were considered too poor operative risks for cholecystectomy. Not one of these patients was found to have a gall-bladder which functions normally, yet only three of these fifteen patients have noted a return of gall-bladder symptoms.

Our findings, then, coincide with those of Spurling and Whitaker in nineteen out of the twenty cases, *viz*, that drainage of an obviously diseased gall-bladder does not bring about a return of normal function, at least in so far as can be determined by the cholecystogram.

In answer to the first question does drainage of the normal gall-bladder interfere with its subsequent activity, eight cases are presented in whom the gall-bladder appeared normal at operation, and gave every indication of being a functioning organ. The gall-bladder was opened in these cases for purposes of diagnosis and in the last five cases for the removal of stones.

TABLE V

CASE I—Female, aged fifty years Pre-operative X-ray diagnosis—Normal gall-bladder Operative diagnosis and findings—Normal gall-bladder One adhesion No stones Time since gall-bladder drainage—Four years Post-operative X-ray diagnosis—Normally functioning gall-bladder Symptoms since cholecystostomy—No symptoms Operative findings secondary operation—None

CASE II—Female, aged forty-three years Pre-operative X-ray diagnosis—Border-line gall-bladder Large gall-bladder Poor emptying Operative diagnosis and findings—Normal-appearing gall-bladder Large Few adhesions No stones Time since gall-bladder drainage—Four years Post-operative X-ray diagnosis—Normally functioning gall-bladder Symptoms since cholecystostomy—No symptoms Operative findings secondary operation—None

CASE III—Female, aged thirty-three years Pre-operative X-ray diagnosis—None Operative diagnosis and findings—Normal-appearing gall-bladder No stones Time since gall-bladder drainage—Two years Post-operative X-ray diagnosis—Normally functioning gall-bladder Symptoms since cholecystostomy—No symptoms Operative findings secondary operation—None

CASE IV—Male, aged fifty years Pre-operative X-ray diagnosis—None Operative diagnosis and findings—Normal gall-bladder Several small stones Time since

In only one out of twenty cases, where the operative findings showed evident cholecystitis, was there a normally functioning gall-bladder as shown by cholecystogram. These findings confirm those previously published by Spurling and Whitaker.

Eight cases were studied in which the gall-bladder appeared normal at operation. Five of these cases showed normal gall-bladder function, three non-calculous and two stone cases. In three cases, in which stones were removed at the primary operation, impaired function was noted by cholecystogram.

Gall-bladder function which was lost before operation cannot be recovered following cholecystostomy. Those which function normally before operation may retain their function after cholecystostomy.

The operation of cholecystostomy *per se* does not greatly disturb subsequent gall-bladder function.

The authors desire to express thanks to the Social Service department for aid in obtaining follow-up observations on many of these patients and to the X-ray department of the University Hospital for their cooperation in making the post-operative cholecystograms.

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ulcerates early and produces a bloody, stinking discharge. In the late case of this variety of carcinoma, not infrequently there are exuberant granulations forming the so-called cauliflower growth.

Adeno-carcinoma, on the other hand, is less frequent, is hard to the touch, and ulcerates much later than does the squamous-cell carcinoma. Early cancer originating within the cervical canal, as one can readily understand, is more likely to be overlooked than cancer of the vaginal surface of the cervix, therefore when in doubt the cervix should be split and the canal inspected, when the diagnosis is readily made.

Operable carcinoma of the cervix comprises the group where at best one can say the cervix only is involved. Where there is invasion of the surrounding vaginal walls or the vesico-cervical parametrium, operation promises nothing in the way of cure.

With the abdomen opened, and a wide exposure, one can decide this question. As far as I am able to say, in border-line cases nothing other than this can definitely settle the question. I do not think operation should be made indiscriminately, nor radium or X-ray administered until the most careful and painstaking examination has been made by the surgeon, but I fear that too often the treatment is determined by the doctor and the radiologist or the roentgenologist. I cannot think this is the best for the patient any more than I think that the operating surgeon is as well fitted to determine the proper dosage of radium or X-ray as is the radiologist or the roentgenologist.

Carcinoma of the body of the uterus is a different proposition from carcinoma of the cervix, in that it occurs much less frequently (in only about 10 per cent of the cases) and has not the same high mortality. The diagnosis however, is less certain on account of many other conditions that may simulate it and, like carcinoma of the cervix, it is not visible to the eye. Bleeding from the uterus in a woman of cancer age and beyond the menopause, with no evidence of disease of the cervix and in the absence of an enlarged uterus, should make one think of cancer. The appearance of the cervix, if enlarged, and if it bleeds upon manipulation or the introduction of a sound, should suggest the possibility of endocervical or fundal carcinoma. Submucous fibroid, hæmorrhagic endometritis, polypoid endometritis and essential hæmorrhage with anæmia are conditions to be borne in mind in making the diagnosis. Diagnostic curettage and microscopic examination of the scrapings should be made in doubtful cases. Carcinoma of the body of the uterus, especially fundal carcinoma, rarely bleeds as freely as a submucous fibroid, hæmorrhagic endometritis, or polypoid endometritis. Spotting is one sign of carcinoma and calls for immediate investigation. With the abdomen open, if there is still doubt, hysterotomy and careful examination will solve the riddle. Many of my gynecologic friends know my fondness for the latter operation, which, while they do not approve of it, has given me more satisfaction and enlightenment than almost any other operation made upon the uterus. One of the strongest arguments in its favor is that it has practically no mortality, dispels doubt, and reveals the truth. I take it there is no difference of opinion with re-



edge of tumor growth. If clinical evidence were not sufficiently reliable to support this latter theory, it certainly can be maintained on the strength of histologic studies. I need but refer to clinical cases of leucoplakia of the tongue or buccal mucous membrane that show cancerous transition in which sections of tumor show at their periphery tumor cells encroaching upon the leucoplakia epithelium. According to some observers a similar leucoplakia of the cervical mucosa is demonstrable with the aid of the colposcope, indicating at first more or less slowly progressing change from normal to pathologic tissue, the first abnormality being a leucoplakia and the last one cancer. The logical conclusion from these observations would be for all women to undergo periodic vaginal examinations in order to forestall any potentially malignant change. This would represent the ideal we are striving for—prevention. Unfortunately, we do not get the cases early. This is all the more regrettable inasmuch as the victims so often are in the prime of life and are snatched away from their families at a time when the maternal influence is so essential for the training of the adolescent youth.

Opinions are divided as to the virtues of surgery as compared with radiation. Unfortunately, Curie therapy is not as yet synonymous with cure, and neither the radiologist nor the roentgenologist nor the surgeon can claim very brilliant results. The gist of the matter is that we are still floundering. However, a recent survey of end-results of 140 cases in the Lankenau Clinic from October, 1920, to January, 1929, shows that the expectancy of life after operation is somewhat better than after radiation or X-ray alone.

The mortality of the entire group during the nine years was 57.8 per cent. Eighty-three received radium only. This group shows the highest mortality—(70 per cent), eighteen were treated by operation and radium, ten of these died, showing a mortality of 55 per cent, while the thirty-nine treated by operation alone gave a mortality of 33.3 per cent.

On the other hand, in view of the fact that many cases are already hopeless when first seen, radium treatment is less distressing than operation and provides temporary improvement. I would say that radium is of value also not only in bringing some cases to a state of operability, as referred to previously, but that it is especially valuable for those whose general condition, age, *etc.*, forbid radical surgery. Furthermore, if and when it cures, it does so without mutilation, a fact of especial importance to the younger patients.

Opinions seem to agree that radium and X-ray give the best results in squamous-cell carcinoma, but not in the pearly body squamous-cell carcinoma. The type of tumor in the above series was squamous-cell carcinoma, 33, cylindrical cell, 2, adenocarcinoma, 25, no pathologic diagnosis, 80.

Of the squamous-cell carcinomas, nineteen were treated by operation, four of which were also given radium. Of the fifteen four were living and well at the end of the period of this investigation, three living with metastasis, one living with a vesico-vaginal fistula, one living and well at twenty-seven months, then lost sight of, and six were dead.

The one is diagnostic curettage. A number of clinicians object to diagnostic curettage because of the danger of disseminating cancer cells in case the condition is malignant. I cannot agree with them. Another is the question of glandular involvement as affecting end-results. It is only by study of glandular involvement that the comparison of results of the two forms of treatment would be valid, and finally let me call attention to one item that acts to the detriment of both forms of treatment. I refer to the fact that surgery is often performed by the unskilled operator and radium is used by men without the special experience and knowledge required for the proper selection of cases. There is no way to remedy these facts except by education and propaganda.

In the question of prognosis great stress is now being laid on the grading of tumors according to their degree of malignancy. This is so essentially the province of the pathologist that I have asked Doctor Reimann to provide some thoughts on the subject, which he has kindly consented to do. Doctor Reimann says: Hardly any discussion of malignancy is heard today without reference to the grading of tumors. This is not a recently discovered method for adding information to what we can discover about any individual tumor, for there is no doubt but that Johannes Mueller, when he first levelled his newly manufactured achromatic microscope at tumors, attempted to correlate the histological pictures with their behavior. But a really new type of grading has been evolved during the last twenty years and the pathologist's knowledge, incidentally often his usefulness too, have been considerably increased since the advent of the X-ray and radium in the treatment of malignancy, for now he attempts to "grade" malignancy according to its sensitivity to these physical agents.

Unfortunately, these two types of grading, *i e.*, according (1) to prognosis and (2) to X-ray sensitivity, are blended and confused in the minds of many surgeons and roentgenologists and, I might add, pathologists too. The one type of grading attempts to forecast end-results, an entirely different prediction from the second type, which judges whether or not a tumor will be destroyed by the therapeutic use of X-ray or radium.

In more than one communication<sup>1</sup> and in many places, I have stated unequivocally that while the former cannot be done, the latter can be accomplished with a considerable degree of accuracy.

The *a priori* reasons why prognostic tumor grading cannot be done are so obvious that it is strange indeed that so much time is wasted on the endeavor, especially since these reasons have been so abundantly confirmed by the results of various approaches to the problem. If the surgeon completely removes a carcinoma, it will not return. If it is not completely removed, the particles left behind will continue growing. How can a microscopic section reveal how thorough the removal has been? How can a pathologist learn from the removed specimen the location of any tumor tissue that has been left behind? Since the microscopic appearance of most tumors varies in different parts sufficiently to influence the criteria of grading, how many and which specimens shall we take? Besides, various parts of tumors grow at unequal

to radium and X-ray is damage to surrounding healthy tissues, which, unfortunately, occurs often enough

Therefore, irrespective of details, once the pathologic diagnosis of carcinoma is made, every possible means of extirpation should be used if the judgment is that there is a chance of complete removal, and no detours by grading or other such considerations should be allowed

In conclusion, may I say that the speaker's impression is that there are many radiologists who agree that in the early case of cancer of the uterus radical surgery offers the best chance of a cure beyond the five-year period. Furthermore, they realize that glandular involvement is beyond the scope of radium but may be reached with the knife. In view of the fact that in about 40 per cent of cases the regional glands are already cancerous when the patients come for treatment, and that the radiologist cannot tell beforehand whether or not the glands are involved, he may treat cases in which radium is useless and thus deprive them of the benefits of surgery which may effect a cure in about 25 per cent of cases with glandular involvement. These, I take it, clearly indicate that the time has not yet arrived altogether to discard surgery in the treatment of cancer of the cervix. The sum total of the question lies in moderation. The operable cases should have the advantages of surgery and the inoperable ones the consolation of radium.

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The accumulation of fluid expands the capsule and stretches the ligaments of the joint, it interferes with the circulation and irritates the nerve apparatus, which, in turn, causes spasm of the muscles. The blood is absorbed slowly from the joint, it produces inflammatory changes of the synovial membrane. Fibrin is precipitated and organized, it may form a nucleus for the development of loose bodies. The cartilages undergo degeneration. The immobilization of the joints finally can give rise to atrophy of muscles and bone.

The truth of these arguments is established by experimental and clinical evidence. Alfonse Jaffe<sup>9</sup> has already, in 1897, demonstrated that blood injected into joints of rabbits is only very slowly absorbed, and that it irritates the synovial membrane by precipitation of fibrin. Hueter<sup>10</sup> proved that injured cartilage is overgrown by connective tissue, if the joint be immobilized. Albert Key<sup>11</sup> recently amplified and confirmed these experiments.

The clinical evidences of the damage rendered to the joints by hæmarthrosis is very clearly demonstrated by the arthritis which occurs in hæmophilia. Here we have repeated bleeding into the joints, which we do not dare to evacuate. As a result, all joint structures undergo pathologic changes. The synovial membrane is inflamed, hypertrophic, imbibed with iron pigment. The cartilages are eroded, the articular surfaces are hypertrophic, the capsule and ligaments are thickened and fibrotic. The result is a severe, chronic osteo-arthritis.

In papers published recently, Kling<sup>12 13</sup> has demonstrated that in severe injuries of the knee-joints the effusion contains fat- and bone-marrow cells besides blood. These elements derived from the fat pads and bone marrow are absorbed with still greater difficulty than blood, they add to the irritation and inflammation of the joints and are a source of loose body formation.

These findings explain the occurrence of chronic osteo-arthritis with loose body formation after severe injuries which were treated without aspiration of the effusion.

The objections against early aspiration of traumatic joint effusions are the possibility of infection and recurrence of the hæmarthrosis. Both are not supported by the experience. Aspiration under ordinary aseptic precautions is harmless. We do not know of one case of infection. Re-aspiration of traumatic effusions is necessary only in a small percentage of cases. The second aspiration shows the effusion to be either serosanguinous or entirely free of blood. The absorption is therefore considerably quicker and the danger of precipitation and irritation is reduced.

Our procedure in traumatic effusions of the joint consists of aspiration 24 hours after injury. The severity and the type of the injury are then determined by examination of the fluid, and clinical method. Cases of simple traumatic synovitis are mobilized immediately and walking is permitted after a few days if the effusion did not re occur. This management gave us complete recovery within 10 days in over 100 cases of injury with hæmarthrosis, due to tear in the capsule. Injuries to the cartilages and inter-arti-

The immediate effect of the aspiration is a relief of pressure and irritation of the nervous apparatus. Relaxation of muscle spasm takes place and the range of motion is greatly increased. The limb can be brought into correct position and local therapy can be applied with greater efficiency.

*Diagnostic Consideration*—Even less recognized than the therapeutic is the diagnostic significance of the aspiration of joint fluids. A number of authors have been quoted in favor of aspiration of traumatic effusions for the curative action, but no reference could be found of an attempt to determine the severity of injuries by examination of the aspirated fluids. The hæmorrhagic character is the only criterion given for traumatic fluids. My studies revealed the presence of fat and bone-marrow elements besides the blood in severe injuries of the knee-joint. On the basis of these findings a differential diagnosis of injuries has been worked out. In slight injuries with tear in the capsule, only blood is found in the effusion, in cases of rupture of the semi-lunar cartilages and intra-articular fractures, fat is torn from the depots in the joints or from the bone marrow and appears in the effusion. Finally, myelocytes and nucleated red cells can be demonstrated in the sediment from the effusion in intra-articular fractures.

This method sometimes gives positive results in avulsions of the articular surfaces of the knee-joint which are not reproduced in X-ray plates, it is also able to clear the diagnosis in cases complicated by a previous injury to the joint or an inflammation.

The differentiation between inflammatory and traumatic effusions is another problem of importance from both a scientific and a practical point of view. Especially in compensation and liability cases do we have to prove the claim of accident by objective methods. The presence of blood in the aspirated effusion is of service only in recent injuries. Its value is further decreased by a possible addition of blood to the fluid from a puncture of a vessel during aspiration. On the other hand, the absence of blood does not disprove the traumatic origin. The blood could have been already absorbed from the synovial cavity at the time of aspiration. In a study<sup>1</sup> I have demonstrated that the bilirubin content is an indication of the origin of the aspirated fluid. Inflammatory fluids have a bilirubin content slightly lower than the blood serum.

Traumatic effusions have a higher quantity of bilirubin than the serum. The increase is accounted for by the breaking down of blood corpuscles and local production of bile pigment from the hæmarthrosis in cases of traumatic synovitis. In fractures also, venous blood from the bone marrow, which is rich in bile pigment, enters the joint cavity. The icteric index is a simple and reliable method for the estimation of the bilirubin content of joint effusions. An icteric index higher than 6 is pathognomonic of traumatic effusion. The icteric index increases with the age of the effusion. The introduction of permanent standards has simplified the bilirubin estimation according to Van den Bergh's method, which has the advantage of being more specific. An indirect Van den Bergh over 0.25 units indicates a local

finally a scar followed. In a small series of cases we have confirmed these results. However, this work is as yet in a preliminary stage.

The etiology of nonspecific arthritis is far from a definite solution. The finding of different bacteria and of protozoa in blood, faeces and different foci is not conclusive proof of an etiologic relation to a case of arthritis. Only when organisms are cultivated from the joint fluid or membrane are we reasonably sure that the arthritis is a product of their activity. The number of positive findings varies with different authors. In the bacteriology laboratory of the Hospital for Joint Diseases, about 20 per cent of the fluids examined developed colonies of streptococci, staphylococci or diphtheroids. However, most of the cultures were not positive before one month's incubation. This diminishes the practical value and the reliability of the results.

The study of the cells in the synovial fluid gives some indication of the underlying process. In acute arthritis the number of cells is increased proportionately to the virulence of the infection and polymorphonuclear leucocytes are predominant. In chronic arthritis, monocytes and small lymphocytes increase in number irrespective of the etiology. Forkner, on the basis of his own studies and a review of the literature, came to the conclusion that a count of over 11,000 leucocytes and 60 per cent polymorphonuclear leucocytes in chronic nonspecific arthritis is likely to be associated with a positive bacterial infection. A cell count under 5000 with under 50 per cent polymorphonuclears is likely to be negative bacteriologically.

Kling<sup>25</sup> has recently called attention to the practical significance of the increase of cells derived from the synovial membrane. A differential count which shows 15 per cent of synovial cells indicates proliferation of the synovial lining, and an increase of these cells to 25 per cent is characteristic for a villous synovitis. The differential count of the synovial cells is therefore of value for selection of the cases which require synovectomy or other surgical procedures.

The chemical examination of the synovial fluids has not yet advanced to the point where it could be of practical value for differential diagnosis. A beginning in this direction was made by Nathaniel Allison<sup>26</sup> and his co-workers. In four cases of bacterially infected fluids these authors found the sugar content markedly low and only moderately so in two cases of tubercular effusions.

The pH estimation is of some value for prognosis in cases of purulent arthritis. I have found that only severe cases give acid reaction. If the reaction is alkaline, or changes on repeated examination to alkaline, the prognosis is favorable.

Only a few remarks on the technic need be made. The joint to be aspirated is prepared by washing with alcohol and applying iodine. The point of entrance and the underlying deeper tissues to the capsule are anæsthetized with 2 per cent novocaine. It is very important to employ needles of large gauge because the synovial fluid is of high viscosity and thick and particles suspended in the fluid are apt to clog needles of smaller gauge. With a wide

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## B FRANKLIN BUZBY

Twisted knee in game Pathology—Loose anterior end cartilage Structures removed—Internal cartilage Present function—Full Period until return of full function—Four weeks

W M, aged ten years, male Period since first symptoms—Ten months Length of present attack—Not acute Length of present attack—Not acute Symptoms—Giving way of knee Primary cause—Fall from height, injuring knee Pathology—Loose anterior end cartilage Sessile projection from fat pad Structures removed—Internal cartilage Sessile body Present function—Full Period until return of full function—Five weeks

L H, aged thirty-eight years, male Period since first symptoms—Three weeks Length of present attack—Three weeks Symptoms—Limited flexion, extension and effusion Primary cause—Getting up from knees Pathology—Transverse tear Hypertrophied fat pad Structures removed—Internal cartilage Fat pad Present function—Full Period until return of full function—Seven weeks

A M, aged fifty-two years, female Period since first symptoms—Four weeks Length of present attack—Not acute Symptoms—Locking of knee and effusion Primary cause—Frequent falls from old recurring external dislocation of patella Pathology—Transverse tear Structures removed—Internal cartilage Present function—Full Period until return of full function—Three weeks

E B, aged twenty-four years, male Period since first symptoms—Three weeks Length of present attack—Three weeks Symptoms—Limited extension and effusion Primary cause—Twisted knee in game Pathology—Transverse tear Structures removed—Internal cartilage Present function—Full Period until return of full function—Four weeks

M P, aged twenty-one years, female Period since first symptoms—Three years Length of present attack—Not acute Symptoms—Locking on flexion Primary cause—Twisted knee in fall Pathology—Transverse tear Structures removed—Internal cartilage Present function—Full Period until return of full function—Seven weeks

R L, aged thirty years, male Period since first symptoms—Four days Length of present attack—Four days Symptoms—Limited extension and effusion Primary cause—Twisted knee in misstep Pathology—Bucket-handle tear Structures removed—Internal cartilage Present function—Full Period until return of full function—Eight weeks

A C, aged forty-four years, female Period since first symptoms—Five years Length of present attack—Not acute Symptoms—Locking of knee Primary cause—Twisted knee in fall down steps Pathology—Bucket-handle tear Structures removed—Internal cartilage Present function—Full Period until return of full function—Four weeks

B K, aged fourteen years, male Period since first symptoms—Two years Length of present attack—Not acute Symptoms—Aching and giving way of knee Primary cause—Twisted knee in fall Pathology—Loose anterior end of cartilage Structures removed—Internal cartilage Present function—Full Period until return of full function—Seven weeks

A M, aged fifty years, female Period since first symptoms—Nine months Symptoms—Effusion, limitation of all motion Held in 20° flexion Primary cause—Twisted knee in fall Pathology—Bucket-handle tear Sessile bodies on fat pad Structures removed—Internal cartilage Sessile bodies Present function—90 per cent Flexion limited 20 per cent Period until return of full function—Twelve weeks

E S, aged thirty-five years, female Period since first symptoms—Six weeks Length of present attack—Six weeks Symptoms—Limited extension and effusion Primary cause—Twisted knee in fall Pathology—Transverse tear Structures removed—Internal cartilage Present function—75 per cent Period until return of full function—Twenty-four weeks

L P, aged seventeen years, male Period since first symptoms—One year Length



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cause—Getting up from knee Pathology—Bucket-handle tear Structures removed—Internal cartilage Present function—Full Period until return of full function—Five weeks

A G, aged fifteen years, female Period since first symptoms—Six months Length of present attack—Not acute Symptoms—Aching and weakness Primary cause—Twisted knee in automobile accident Pathology—Transverse tear Structures removed—Internal cartilage Present function—Full Period until return of full function—Six weeks

K D, aged thirty-eight years, female Period since first symptoms—Six months Length of present attack—Six months Symptoms—Limited flexion and extension Primary cause—Twisted knee in fall on street Pathology—Transverse tear Structures removed—Internal cartilage Present function—Full Period until return of full function—Five weeks

C W, aged thirty-eight years, male Period since first symptoms—One year Length of present attack—Two days Symptoms—Limited flexion and extension Primary cause—Getting up from knees Pathology—Bucket-handle tear Structures removed—Internal cartilage Present function—Full Period until return of full function—Seven weeks

### TORN EXTERNAL SEMILUNAR CARTILAGES

D S, aged eighteen years, male Period since first symptoms—Two months Length of present attack—Not acute Symptoms—Clicking and snapping of knee Primary cause—Twisted knee in fall Pathology—Transverse tear Structures removed—External cartilage Present function—Full Period until return of full function—Four weeks

R A, aged fourteen years, male Period since first symptoms—One week Length of present attack—One week Symptoms—Limited flexion and extension and effusion Primary cause—Fell from pony, twisting knee Pathology—Transverse tear Structures removed—External cartilage Present function—Full Period until return of full function—Four weeks

### OSTEOCHONDRITIS DISSECANS

O S, aged twelve years, male Period since first symptoms—Six weeks Length of present attack—One day Symptoms—Locking, effusion and limited extension Primary cause—Twisted knee getting up from kneeling Pathology—Loose body Structures removed—Loose body, external cartilage Present function—Full Period until return of full function—Ten weeks Recurring effusion until then

W D, aged nineteen years, male Period since first symptoms—Three years Length of present attack—Not acute Symptoms—Recurring slipping, limited extension Primary cause—Came on while walking Pathology—Loose bodies Thickened internal cartilage Structures removed—Loose bodies Internal cartilage Present function—Full Period until return of full function—Six weeks

P W, aged sixteen years, male Period since first symptoms—Six weeks Length of present attack—Not acute Symptoms—Locking and chronic effusion Primary cause—Came on while walking Pathology—Loose body Loose anterior end internal cartilage Structures removed—Loose body Internal cartilage Present function—Full Period until return of full function—Twelve weeks Recurring effusion until then

### INTRA-ARTICULAR EXOSTOSES

E R, aged sixty-four years, female Period since first symptoms—One year Length of present attack—Not acute Symptoms—Pain Locking hæmarthrosis on walking Primary cause—Unknown Pathology—Intercondylar exostosis femur Hyalinized fat pad Hæmarthrosis Structures removed—Exostosis Fat pad Present function—Full Period until return of full function—Seven weeks

J B, aged twelve years, male Period since first symptoms—Seven months Length

villous arthritis An exostosis on the posterior aspect of the patella was removed in one case of villous arthritis A hypertrophied post-patellar fat pad was removed in one of the cases of intra-articular exostosis

Due to weight-bearing and the type of joint, the knee is more apt to become damaged than any other joint in the lower extremity When the knee is flexed, the inner femoral condyle is rotated or glides on the internal semilunar cartilage on a fixed tibia When extended, there is no rotatory or lateral motion possible in the knee, due to rigidity of the muscles and to the stretch put on the capsule and ligaments about and within the joint

Due to this rotatory or gliding motion at the region of the inner cartilage, this structure is the one more apt to give way with seemingly trivial injury This same twisting motion must be severe to be extended to the outer portion of the knee and for the outer cartilage to become damaged, since the external meniscus, while also attached to the tibia, glides with the femur Accordingly, there are far more internal than external menisci torn, about ten to one

The anterior end of each semilunar cartilage is but loosely attached to the capsule of the joint by the coronary ligaments, which are very weak structures The posterior portion of the cartilage is very firmly attached to the lateral ligament, and so fractures or transverse tears take place at the junction of the two portions due to the difference in mobility of the two ends Practically never does a cartilage become completely displaced Instead, we find one or two longitudinal splits in the cartilage, the so-called bucket-handle tear, extending almost the whole length of the structure, or a transverse or oblique tear of the meniscus

The post- or infrapatellar fat pad, in the sagittal section, is a triangularly shaped structure located below the patella and behind the patellar tendon, covered on its posterior surface by synovial membrane This structure may have finger-like processes extending backward which cover the anterior end of each cartilage and which are held there by the ligamentum mucosum, which is a thin strand of synovia attached posteriorly just in front of the anterior crucial ligament in the femoral intercondylar notch These alar pads are often crushed between the femur and tibia on internal rotation of the femur on the fixed tibia, followed by inflammation, swelling and thickening and, with this already damaged and swollen structure extending into this hinge joint, similar trauma is apt to be frequently repeated Adhesions may form between this pad and the loosely attached front end of the cartilage, dragging it out of place and thus causing repeated locking of the joint Timbrell Fisher states, "No operation on a semilunar cartilage is complete which does not include the removal of this thickened and inflamed process when present, and conversely it is unnecessary to remove the cartilage when it is clear that the process is solely responsible for the symptoms"

But for the passive part of resistance played by the lateral ligaments in damage to cartilages, they have little else to do with internal derangements of the knee requiring surgery except in knees which, when fully extended, show some lateral mobility where normally there should be none Here cartilages

between ten and fifty-two years. The mechanism in the knee was always a twist, except one case which was incurred in an automobile accident, and probably this was also a twist. Four of these twists occurred in getting up from kneeling.

The symptoms of which the patients complained in the cases in which motion was not limited at the time of operation, fifteen in all, were mainly aching, and pain on use, with recurring slipping and giving way of the knee or locking of the joint. In the remaining nineteen the complaint was limited extension, and limited flexion as well in a few, effusion, pain and loss of full function. In this latter group the shortest period of limited motion before operation was two days and the longest nine months, which patient incidentally, had had many chiropractic and osteopathic efforts at reduction without avail. In this case at operation all the structures in and about the knee were damaged including the articulating surface of the tibia and femur. Three months after operation she still lacked twenty degrees of full flexion.

The nature of the laceration of the cartilage was found to be almost half the transverse or oblique tear, almost a third of the bucket-handle type and the remainder showed a displaced anterior end probably produced by the drag of adhesions to this end of the cartilage.

<i>Causes of Torn Cartilages</i>		<i>Types of Torn Cartilages</i>	
Sports	9	Transverse or oblique	16
Falls	13	Bucket handle	12
Twists while walking	7	Loose end	6
Getting up from knees	4		—
Automobile collision	1	Total	34
	—		
Total	34		

Seven cases of damaged cartilage showed hypertrophy of the post-patellar fat pad as well, which was also removed in whole or in part at the time of operation. Only three cases showed any loss of function as an end-result, one which one year later had to have a synovectomy for villous arthritis, and who had had recurring cartilage impingement for ten years with recurring hæmarthrosis, complicated during this period by a monarticular arthritis. Now, a year following synovectomy, he has 80 per cent function, the loss being in lack of flexion, a second already referred to above, and a third, a tuberculous subject who had, in addition to the torn cartilage, a severe injury to the lateral ligaments of the knee as a result of a fall into a hole in the floor, and whose motion post-operatively was not forced, fearing that a tuberculous synovitis had already set in. This last patient after six months had about 75 per cent function, this loss being again lack of flexion beyond one hundred ten degrees. Including these three whose convalescence was long, the average time for return of fullest possible function in cartilage tears was six and three-tenths weeks, the usual time being about five weeks, and the shortest three weeks, four patients having discarded all support, had full motion, no limp or feeling of weakness after this short period.

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The other case had an intercondylar growth which showed a typical snapping knee, the only patient in the series showing this symptom which is usually caused by a torn external or the detached posterior end of an internal cartilage

## ELAPSED TIME UNTIL ARTHROTOMY DONE

<i>Cause of Derangement</i>	<i>Since First Symptoms</i>			<i>Since Last Attack in Irreducible Cases</i>		
	<i>Shortest</i>	<i>Longest</i>	<i>Average</i>	<i>Shortest</i>	<i>Longest</i>	<i>Average</i>
Internal semi-lunar cartilage	4 days	16 years	28 1 months	2 days	6 months	3 2 weeks
External semi-lunar cartilage	1 week	2 months	5 weeks			15 cases
Osteochondritis dissecans	6 weeks	3 years	13 months	1 day		1 day
Villous arthritis	2 years	11 years	63 months			1 case
Sessile growths from fat pad	2 months	4 years	10 2 months			
Intra-articular exostoses	7 months	12 months	9 5 months			

The differential diagnosis of these derangements necessitating arthrotomy from the many sprains, contusions, general chronic arthritides and the more acute monarticular infections in which operation is not indicated, is something which tries our skill

In cartilage cases the tender spot found just above the edge of the tibia three-quarters of an inch posterior to an imaginary line dropped from the margin of the patella is a very valuable sign, along with the history of locking or giving way. In this series air injection was not used. Although advised by many it is felt the interpretation of X-ray findings is rather difficult. Unfortunately, the X-ray rarely gives any help in cartilage and fat-pad changes and seldom in osteochondritis.

An observation not constant but still valuable, is that most often in the locked bucket-handle tear the motion is limited by resilient resistance in both flexion and extension, while in transverse or oblique tears, fat-pad changes and osteochondritis, extension alone is limited. Certainly, recurring locking and effusion with acute localized tenderness in the knee is indication enough for arthrotomy.

## KNEES WITH LIMITED MOTION AT TIME OF OPERATION

<i>Cause of derangement</i>	<i>Number of Cases</i>	<i>Number of Joints Limited in Motion</i>	<i>Percentage</i>
Laceration internal semilunar	32	18	56 2
Laceration external semilunar	2	1	50
Osteochondritis dissecans	3	1	33 3
Villous arthritis	4	2	50
Sessile growths from fat pad	4	3	75
Intra-articular exostoses	2	1	50
Totals	47	26	55 3

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For exploration of the knee-joint and for synovectomy the Jones patella-splitting incision is most valuable. This was used in eight cases. In this, because of the prominence of the lateral femoral condyle, it is important to divide the patella not in its middle but at a point two-fifths of its width from the outer edge, thus permitting easy retraction of both portions over the respective condyles. The longitudinal parapatellar incision was used but once and that in a definite fat-pad injury.

### INCISIONS USED

<i>Indication for Arthrotomy</i>	<i>Number of Cases</i>	<i>Fimbiell, Fisher</i>			<i>Longitudinal Parapatellar</i>
		<i>Semilunar</i>	<i>Jones Split Patella</i>		
Laceration internal semilunar	32	30	2		
Laceration external semilunar	2	2			
Osteochondritis dissecans	3	3			
Villous arthritis	4		4		
Sessile growths from fat pad	4	2	1		1
Intra-articular exostoses	2	1	1		
Totals	47	38	8		1

The rubber-tissue drain is removed forty-eight or seventy-two hours after operation, at the first dressing, and the splint at the end of five to seven days, depending on the amount of swelling, except in those arthrotomies with the Jones split-patella approach. I believe the comfort obtained by the patient from the splint far outweighs any fear of stiffness and delayed return of motion in the joint. The argument advanced by those who do not use post-operative fixation. Passive and guided active motion within the range of comfort is started with the removal of the splint, and within twenty-four to seventy-two hours after this the patient is gotten up on crutches to walk, bearing weight on the affected leg and bending it naturally in walking. This I believe is extremely important for early return of motion. Practically all patients leave the hospital ten days after operation and all within two weeks.

In those knees requiring the Jones split-patella incision, passive and guided active motion is begun at the end of the third week and crutches are permitted at the end of a month. It is interesting to note, however, that even without suturing, on flexion of the knee while the wound is still open, the femoral condyles hold the patellar fragments in very close apposition to each other.

### ELAPSED TIME UNTIL RETURN OF FULL FUNCTION

<i>Indication for Arthrotomy</i>	<i>Number of Cases</i>	<i>Shortest</i>	<i>Longest</i>	<i>Average</i>
Laceration internal semilunar	32	3 weeks	6 months	6.3 weeks
Laceration external semilunar	2	4 weeks	4 weeks	4 weeks
Osteochondritis dissecans	3	6 weeks	3 months	9.3 weeks
Villous arthritis	4	2 months	8 months	6 months
Sessile growths from fat pad	4	4 weeks	5 weeks	4.5 weeks
Intra-articular exostoses	2	7 weeks	12 weeks	9.5 weeks

# THE BEHAVIOR OF ALCOHOL-PRESERVED FASCIA LATA OF THE OX, AUTOGENOUS FASCIA AND CHROMICIZED KANGAROO TENDON IN DOG AND IN MAN

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WITHIN recent years a great deal of attention has been focused on the use of both living and dead fascia for sutures and ligature materials in surgery. This interest was first aroused by McArthur and by Andrews in hernia operations and greatly stimulated by Gallie and LeMesurier in 1924 in their work on hernia repair, using the autogenous fascia lata as sutures. This step seemed

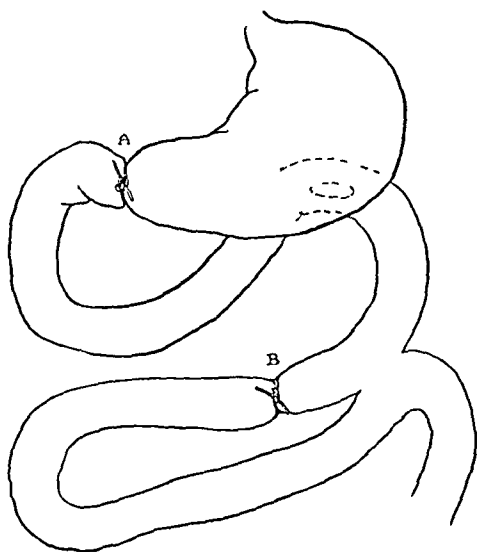


FIG 1.—Diagram showing posterior gastroenterostomy and lateral anastomosis of the jejunum with occlusion by ligatures at 'A' and 'B'.

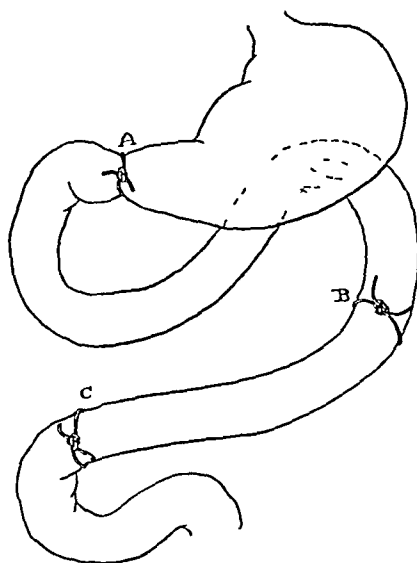


FIG 2.—Diagram showing posterior gastroenterostomy and site of ligatures. 'A' is tied tightly occluding the pylorus, 'B' and 'C' are loosely tied forming no constriction of the jejunum.

to be a distinct advance over the use of absorbable or non-absorbable sutures in certain fields of surgery.

Years before this, Vulliet first described the use of autogenous living sutures in a nephropexy, using a tendon of the latissimus dorsi. In 1901, L. L. McArthur described a method of inguinal hernia repair by using pedunculated strands of the aponeurosis of the external oblique as suture material. Following this, much experimental work was done on the transplantation of fascia, using it in many ways, but it was years later that fascia was first actually used as suture material.

Gallie and LeMesurier showed that autogenous transplanted fascia strips

autogenous living fascia occurs in the same manner in dead fascia preserved in 70 per cent alcohol as in the living "The dead cells of the graft have been replaced by cells from the host, the graft becomes finally fixed to the surrounding tissue by ingrowths of fibroblast, and the implant becomes vascularized" He assumes that the dead and living fascia undergo similar changes

Hutchinson has reported the presence of kangaroo tendon two years after implantation of hernia repair and that the microscopic sections showed them to be normal fibrous tissue, part of the living structure of their host However, the type of preservative was not stated and this has not been the general finding in chromicized kangaroo tendon where absorption occurs

Following this work I have attempted to compare the reaction in the peritoneal cavity and in the abdominal wall of the dog, of the autogenous fascial transplants with that of the alcohol-preserved fascia lata of the ox which



FIG 4



FIG 5

FIG 4—Experiment No 9 Dead fascia ligature on the intestine of a dog five weeks after operation Note that there is no tendency toward encapsulation The fascia has blended with the intestinal coat and is covered externally by peritoneum Along the edges of the fascia vascularization has taken place ( $\times 75$ )

FIG 5—Experiment No 9 Higher power of preceding figure showing the peritonization of the fascia ( $\times 150$ )

Koontz used With these two suture materials I have used for comparison chromicized kangaroo tendon These three materials were tied loosely about the small bowel in the peritoneal cavity, snugly about the pylorus, and also placed in the abdominal wall This would give a comparison of the reaction in the normal habitat of the fascia, when next to muscle and tendon, and in the peritoneal cavity, an entirely foreign surrounding By attempting to occlude the pylorus, the material used would be put under tension by peristalsis and thus the amount of relaxation these structures would undergo in the peritoneal cavity could be determined

*Experimental Work*—All of the experimental work was performed on dogs, sixteen experiments in all being done The experiments extended over periods varying from five days to a little over six months (192 days) Eleven were intra-abdominal and the remaining five in the abdominal wall The living autogenous fascia was all obtained

## ALCOHOL-PRESERVED FASCIA LATA OF THE OX IN ABDOMINAL CAVITY

<i>Experiment</i>	<i>Age</i>	<i>Remarks</i>
1	6 months and 1 week	The ligatures which had been placed about both the pylorus and jejunum could not be definitely identified grossly, nor microscopically. The area where they had been placed stretched normally with the rest of the gut. There were many adhesions about these places.
2	6 months	This one had been placed about the jejunum only, occluding the gut and a lateral anastomosis done. There was no trace of this ligature found grossly nor microscopically, the lumen of the gut was wide open.
4	6 weeks	The ligatures had been placed about both the pylorus and jejunum and appeared to be greatly diminished in size. Many adhesions were present and they stretched under tension. Microscopically, much replacement was noted.
6	5 weeks	The ligature was placed only about the pylorus. Many adhesions were present. The strand was diminished in size and stretched a very little. Occlusion of the pylorus was attempted at the beginning of the experiment, but it leaked water under pressure, the pylorus still seemed to be slightly constricted.
9	5 weeks	The ligature was placed about the jejunum. A few adhesions were present, and there had been considerable reorganization with the formation of blood-vessels in its outer portion. This ligature would stretch under tension (Figs 4 and 5).
8	3 weeks and 2 days	The ligature was placed only about the jejunum. Very few adhesions were noted. There was very little diminution in the size of the ligature, and it did not stretch. Some reorganization was seen microscopically.
10	17 days	There were many adhesions, otherwise the ligature appeared quite normal.
7	5 days	There appeared to be no changes in the ligature. There were a few adhesions present.
3		The dog died at the end of five days from peritonitis, due to a leak in the suture line of the gastroduodenostomy. None of this dead fascia could be found.
11		The dog died of intestinal obstruction on the fifth post-operative day. The ligature appeared normal.

## KANGAROO TENDON IN THE ABDOMINAL CAVITY

<i>Experiment</i>	<i>Age</i>	<i>Remarks</i>
1	6 months and 1 week	The ligature had been placed about both the pylorus and the jejunum. There were only a very few adhesions, and apparently only slight absorption of the ligature, it did not stretch under tension (Fig 3). Microscopically, there was definite encapsulation and some absorption could be noted at the edges. More absorption of the ligature about the jejunum was noted.
2	6 months	The ligature had been tied tightly about the pylorus. A few adhesions were present and the ligature did not appear diminished in size. The pylorus was completely occluded even under great hydrostatic pressure. The ligature had cut into the pyloric muscle a little, and microscopically there was encapsulation of the strand but very little absorption noted.



- |    |        |   |
|----|--------|---|
| 16 | 1 week | There was some blending of the ligature into the surrounding tissue but still a line of demarcation could be made out Microscopically, there appeared to be little or no change from the original |
|----|--------|---|

#### ALCOHOL-PRESERVED FASCIA LATA OF OX IN ABDOMINAL WALL

There could be noted no difference between the behavior of this material and that of the living fascia, so the above may be taken for these observations, too

#### KANGAROO TENDON IN THE ABDOMINAL WALL

<i>Experiment</i>	<i>Age</i>	<i>Remarks</i>
12	6 weeks	The ligature appeared smaller and did not stretch Microscopically, it was encapsulated and showed absorption about the edges (Fig 10)
13	5 weeks	Observations here exactly coincided with the above



FIG 6



FIG 7

FIG 6—Experiment No 4 Kangaroo tendon ligature on pylorus six weeks after operation The ligature has become deeply imbedded in the muscular coat It is definitely encapsulated Due to its resistance part of the kangaroo tendon was displaced in cutting the sections ( $\times 110$ )

FIG 7—Experiment No 4 Higher power of preceding figure showing the encapsulation and slight absorption at the edges

- |    |                       |  |
|----|-----------------------|--|
| 14 | 3 weeks and<br>2 days | There had been a good deal of infection in the incision and none of the material could be found  |
| 15 | 2 weeks and<br>3 days | There had been some infection in the incision, but some of the material was left, though diminished There was no stretching of what remained   |
| 16 | 1 week                | The ligature appeared the same as when placed in the abdominal wall There was some encapsulation microscopically, but apparently no absorption |

Gross examination of the specimens showed that there was very little absorption of the kangaroo tendon and in no instance was there any stretching There was apparently no noticeable difference between the dead alcohol-preserved fascia of the ox and the living autogenous fascia, about both there was a moderate amount of adhesions, more than about the kangaroo tendon The alcohol-preserved fascia of the ox would

the muscular layers when it had been placed about the pylorus under tension (Fig 6) Microscopically, it was also noted that there was more apparent absorption of the kangaroo tendon and replacement of the other two materials when placed about the jejunum than about the pylorus The fact that some were tied under tension did not seem to have any factor in this observation

Where there was peritonitis no trace could be found of the living or dead fascia, but the kangaroo tendon appeared normal though somewhat diminished in size The jejunum was occluded in several instances with each kind of material, a lateral anastomosis being done, but there was no occlusion of the jejunum noted at the time of autopsy, although it was slightly constricted when the kangaroo tendon was used

There was a more rapid encapsulation and absorption of the kangaroo tendon placed in the abdominal wall (Fig 10) than about the pylorus or the jejunum The reverse was true of the living and dead fascia In the abdominal wall the fascial transplants seemed to fade into the surrounding tissue more quickly, but held their original size



FIG 9

FIG 9—Experiment No 12 (2) Living autogenous fascia ligature imbedded in abdominal wall and removed six weeks after operation There is no encapsulation or absorption The fascia has become vascularized along the margins (x75)

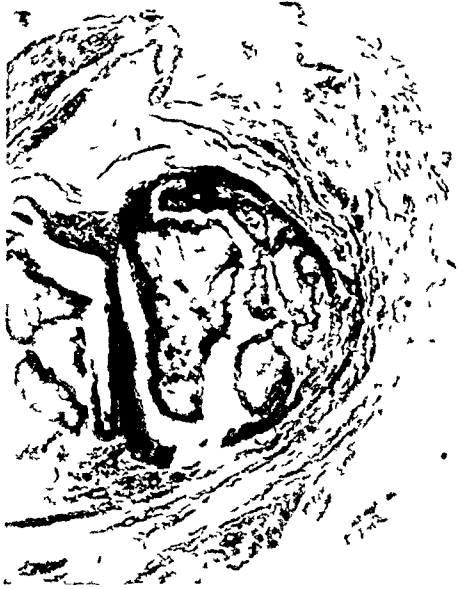


FIG 10

FIG 10—Experiment No 12 (1) Kangaroo tendon imbedded in abdominal wall showing definite encapsulation with absorption about the edges Specimen six weeks after operation (x85)

and strength much longer, which is probably due to the fact that they were more in their normal habitat, fascia and muscle, than when in contact with the peritoneum This also coincides with the observations of others who have attempted to occlude the pylorus with fascial bands and found that the fascia will soon stretch and the pylorus will again become patent

When there was infection in the incision, both types of fascia soon broke down and were quickly absorbed, while the kangaroo tendon was only slightly absorbed In no instance was there encapsulation of the fascia, as occurred wherever the chromicized kangaroo tendon was used and no inflammatory reaction was noted about the kangaroo tendon

The observations on alcohol-preserved fascia lata of the ox as recorded above largely coincide with those of Koontz, but from clinical experience the reactions of this alcohol-preserved fascia lata of the ox in man have been con-

*Comment* —From these cases it is obvious that the alcohol-preserved fascia lata of the ox as obtained on the market does not behave in man like the autogenous fascia lata, but is readily digested and broken down, while the autogenous fascia holds exceptionally well

The reasons for the discrepancy between the experimental and clinical work can only be surmised. The fact that man is further removed from the ox in the biological scale of life than is the dog may be one of the factors here. The tissues of man are more highly organized than are the tissues of the dog, so, while experiments concerning mechanical technic which work out satisfactorily on dogs will probably also succeed in man, but experiments that depend upon the biologic reaction to foreign transplanted tissues may not give the same results in man as in the dog. The fact that man is often sensitized to foreign proteins and may react violently to them when placed in his tissues probably accounts for many of the differences noted in the experiments of tissue transplantation in animals and in man.

#### CONCLUSIONS

1 Dead alcohol-preserved fascia of an ox and living autogenous fascia react similarly in the peritoneal cavity and in the abdominal wall of the dog. In no instance does encapsulation occur.

2 Kangaroo tendon soon becomes encapsulated, and is absorbed more quickly in the abdominal wall than in the peritoneal cavity.

3 The fascias, both dead alcohol-preserved of the ox and the autogenous, atrophy and stretch when placed in the peritoneal cavity, but not in the abdominal wall.

4 For pyloric occlusion chromicized kangaroo tendon is much more satisfactory, forming total occlusion for over six months in the dog and causing fewer adhesions than the fascia. The living fascia seems to occlude the pylorus several weeks longer than the dead alcohol-preserved fascia of the ox.

5 If infection is present, both the living and the dead alcohol-preserved fascia of the ox is broken down and absorbed, while chromicized kangaroo tendon shows a high degree of resistance to infections.

6 The alcohol-preserved fascia of the ox does not react in man as it does in the dog, but is quickly absorbed and loses its tensile qualities, while the autogenous fascia lata in man apparently retains its strength.

7 The reasons for this difference in behavior between the dead alcohol-preserved fascia of the ox in the dog and in man is not definitely determined. It may be due to the fact that man is higher in the biological scale than the dog or ox, his tissues are more complex and consequently the proteins of the fascia lata of the ox are more foreign to his tissues than to the tissues of the dog. One of man's chief articles of food is beef, and this fact, also, may increase the rapidity with which foreign beef proteins are absorbed in man, once they have been introduced into his tissues.

## IMPROVED ARMAMENTARIUM FOR FRACTURE REDUCTION AND RETENTION

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BECAUSE it is felt that a definite step forward has recently been made in the care of certain fractures, the essayist wishes to outline certain practical points concerned with these fractures as seen at the Kansas City General and Research Hospitals. The essayist wishes at this time to acknowledge the help of Dr. R. M. Schauffler in awarding cases for the study and application of these newer methods. Ideas of Dr. M. W. Pickard, and others engaged in traumatic surgery in the Research Hospital have been freely used, and are gratefully acknowledged. The methods chiefly considered are those of Bohler, of Vienna, as employed by Dr. S. R. Cunningham, of Oklahoma City. The latter has applied most aptly, to the American patient the principles which Bohler applies to the Austrian. It is well to note here that there are certain of Bohler's methods which would unquestionably not be tolerated by the average American citizen. Therefore, what is discussed here is technic which has been repeatedly used on Americans and found to be well tolerated by them.

The problems involved in fractures of the long bones are chiefly as follows: (1) Sufficient traction to overcome shortening. (2) Difficulty of applying traction in certain locations (fractures of lower leg, hip, etc.). (3) Lack of appliances affording good retention and at the same time capable of minor adjustments to correct position from time to time. (4) Lack of an alternative to cumbersome plaster cases, general anesthesia and recumbency in certain fractures in the aged. (5) Lack of a good method, without the use of foreign material, in compound fractures following debridement or during Dakinization. (6) Difficulty in restoration of function where extremity had of necessity to remain in plaster. (7) Avoidance of secondary operations to correct deformity, remove metal plates, etc. (8) An appliance or method for immediate use requiring no subsequent change until union takes place.

To illustrate the difficulties encountered in fractures of the leg, I went to the 1929 records at the Kansas City General Hospital. From these I chose at random cases of that year in which the fragments were displaced on admission. Fig. 1 illustrates four cases, the first four encountered which filled the requirement of *displaced fragments when admitted*. It must be stated that these were not all primarily treated in the General Hospital, and after admission were not all cared for by the chiefs of the fracture services. They do, however, represent the average results, I dare say, of the average busy, charity, fracture service in 1929.

CASE I—J G (36299) Showing *posterior bowing of leg* as of February, 1929 The first rontgenograms made at the hospital were dated February 21, 1927 Ones made again in March, 1927, showed a Parham band in place, the bone ends apposed, but posterior bowing, foot drop and bone atrophy The end-result here shown speaks for itself

CASE II—M C (44696) Showing *fracture of the lower third of the tibia* with typical posterior displacement of the lower fragment as of August 6 1929 Note foot drop The same condition obtained at the time of admission, July 31 1929, and before application of the plaster case

CASE III—M C (44530) Showing another *fracture of the lower third of the leg* the day after application of a plaster case (July 16 1929) Note the medial displacement of the lower fragment A Lane plate was applied in August, and rontgenograms as late as October, 1929, show no appreciable callus formation, although good alignment was secured at operation

CASE IV—D R B (44454) Showing *fractures of the upper ends of the tibia and fibula* Note the direction of the line of weight bearing of the upper fragment in relation with the lower fragment as of August 15, 1929 The first pictures were made July 8, 1929 The next films bear the date of July 10, 1929, and showed the leg in plaster, no attempt having been made, or an unsuccessful attempt having been made to reduce the deformity (The rontgenogram is of the leg in plaster six weeks after admission)

Since the introduction of the Bohler splint into the fracture service at the Kansas City General Hospital nine months ago (service of Doctors Dickson and Dively), a score of fractures has been treated on this type of frame A number were made and during the past fall and winter practically all compound fractures of leg or thigh were treated on them The results were highly satisfactory, in our opinion I will illustrate the virtues of the appliance incidental to the case histories given in brief Fig 2 illustrates four cases as nearly analogous to those shown in Fig 1 as it was possible to find

CASE Ia—C (48968) *Compound fracture of both bones of the leg in the lower third*, with massive hematoma of the leg and destruction of skin This lad was placed at once (November 16, 1930) on a Bohler splint Prior to application of skeletal traction position was temporarily maintained with skate cleat on sole of shoe attached to weight cord The debridement was done early without removing the leg from traction Dakinization was used and on several occasions minor adjustments were made, and loose fragments were removed Note that position was maintained until callus formation was sufficient and wound secretion minimal, when a plaster case was applied (January 14, 1931) and the patient allowed up and about in a wheel chair

CASE IIb—L (50305) *Compound fractures of both bones of leg* with considerable comminution There was a coincident skull fracture, and fracture of the right humerus The lad was in coma and delirium for about two weeks The leg was placed at once in a Bohler frame, and debridement done (January 5, 1931) under local anæsthetic A Steinhilber pin was inserted at the same time and the wound Dakinized from then until suppuration had practically ceased Note that the alignment was maintained, and fragments which appeared at first to be of questionable vitality have become incorporated in the callus In this case, as in all of this series, no trouble was had with drop foot or pain, and no foreign material other than Dakin's tube or drain was used (Admitted January 2, 1931 Case applied February 14, 1931)

CASE IIc—F J (50001) *Compound fracture of the lower leg* Steinhilber pin and Bohler frame used early and wound Dakinized The film shows safety pins holding sling under entire length of the leg This is a mistake, and since the advice of Dr M W Pickard has been followed, and the calf of the leg has been permitted to sag, we have

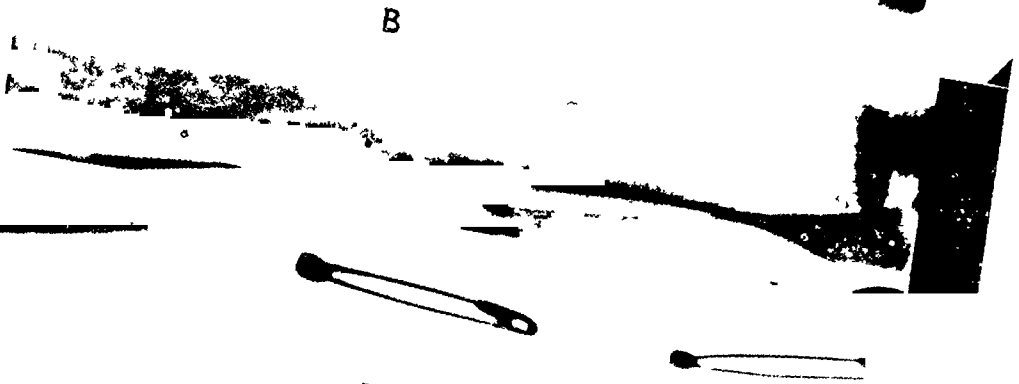
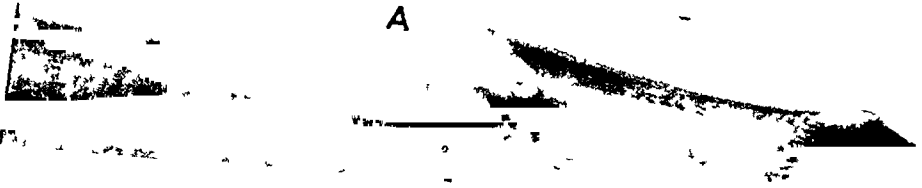


FIG 2—Case IIIc

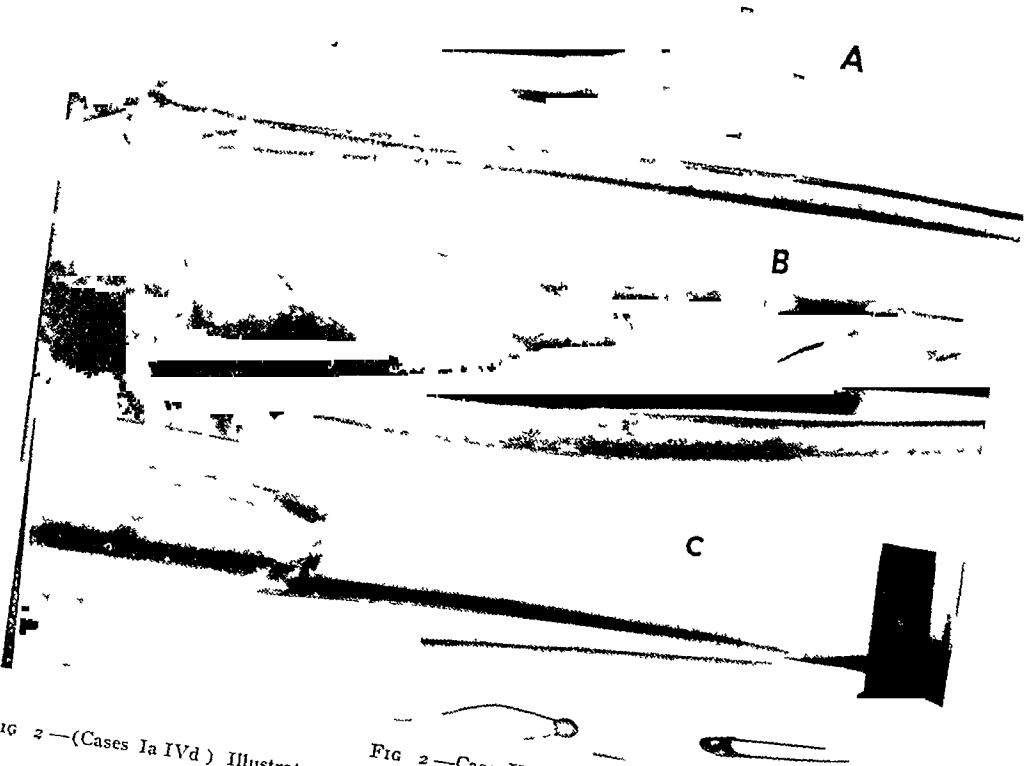


FIG 2—Case IVd

FIG 2—(Cases Ia IVd) Illustrative cases showing difference since use of Bohler traction principles

The photograph (Fig 3b) shows a Bohler screw-traction apparatus with leg suspended preliminary to the application of plaster case. Notice that ordinary gas pipe was used in construction and that a bar beneath the thigh has set screws at either end which permit its elevation and retention at any desired level. The frame may be elongated by loosening the set screws shown beneath the calf of the leg, and pulling the two ends apart. For overhead support a section of metal from a Goldthwaite frame is used as a rule, although a section of gas pipe may be held in place by bandages and has been so used by the author. A hook on a thumb-screw is shown projecting through the transverse pipe of the section extending beyond the foot. If the groin is padded and the frame pressed firmly into the crotch a good deal of longitudinal pull may be exerted through this hook if a few

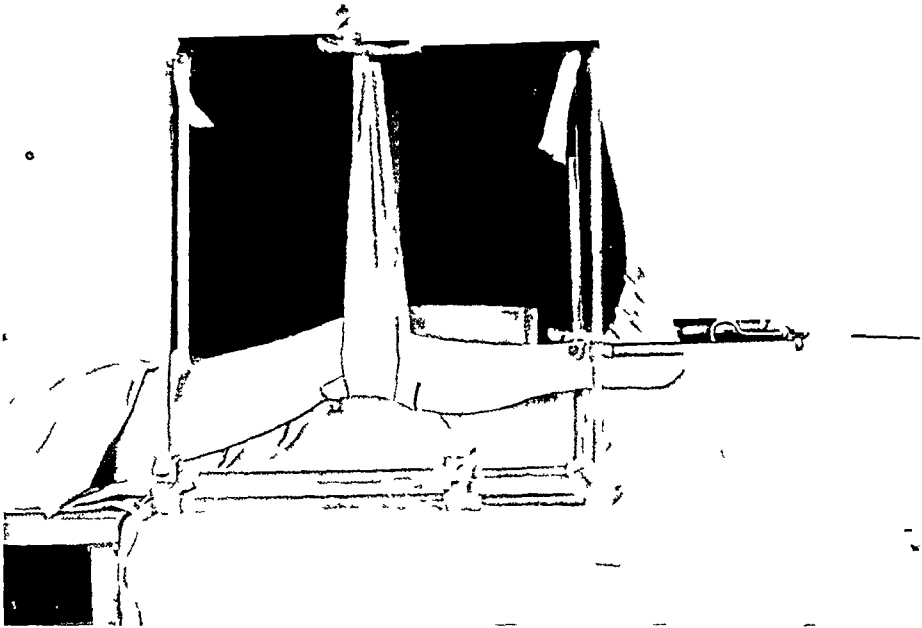


FIG 3b—Bohler's screw traction apparatus for fractures of leg and foot (author's adaptation), with leg in position for casting

turns of plaster are passed through it after first encircling foot and ankle. In fact, it is expedient in certain fractures, notably of the os calcis, to leave the calipers on and attach them to the hook, thus incorporating the Steinmann pin or Kirschner drill in the plaster case.

In using the frame for fracture of the os calcis it is completely shortened, the cross bar, shown here beneath the gluteal crease, is fixed at a point coinciding with the flexed knee, and is well padded. Tongs, Kirschner drill passed through the calcaneus, with metal bow (Fig 8b), or Steinmann pin are then attached to the hook and energetic traction maintained until reduction is secured, when case is applied. A tenotomy of the tendon Achilles according to the method of Straus may or may not be done as a preliminary. A canvas sling under the ankle and lower leg is absolutely necessary, or

not too rapidly, an assistant pressing the outermost guard against the skin, thus helping to direct the wire through the proper point, and in the proper direction

After the wire has sufficiently penetrated, the set screw is unscrewed, the drill removed from the wire, and one of the traction bows clamped over the wire as shown at (4). A number of sizes other than those illustrated [(2), (3) and (4)] have been made at a very low cost by a local machinist.

Hooks such as shown (5) are used to connect the bow with the traction cord, or smaller hooks are used through the perforations. By means of the extra holes, off-centre pull may be exerted, thus helping to overcome lateral angulation of fragments or making up for some minor deviation in the direction taken by the wire in its penetration of the tissues.

Three of the usual sizes of rustless wires are shown, the largest being slightly smaller than the lead in a pencil. When the wire ends have been slipped into the slots on the threaded ends of the traction bow, the nuts are turned down tightly upon the wire with a wrench, and no amount of pull will bend the wire enough to cause any perceptible bowing. The excess wire may be covered with cork at either end, or nipped off with wire nippers such as shown (7). I have yet to hear a patient complain of this wire-traction method. They do not feel the wire enter the tissues, and on withdrawing it there is invariably an expression of wonder that it is out. No special preparation of the skin is needed—simply soap and water and then 7 per cent tincture of iodine. I have not seen an infection follow the use of this drill or the Steinmann pin.

Fig 6 illustrates a type of dressing for fractures of the humerus—especially at the surgical neck. The metal loop is incorporated in the plaster case of the shoulder and arm. In the case shown, the fracture was of the surgical neck, and about thirty-six hours old. Excellent relaxation and perfect anaesthesia were secured by the injection of 2 per cent novocaine solution into the fracture site, and about the olecranon and upper ulna. After the case was applied as shown, a Kirschner wire was drilled through the olecranon and a traction bow attached. As will be seen, a rubber band was used to maintain the pull, and at the end of a day had separated the forearm from the upright plaster shell a full two inches. Some of this was slack taken up against the chest wall, but a good deal was traction effectively applied at the fracture site.

The author has twice applied the Kirschner wire and traction bow on an ordinary Campbell splint. Doctor Cunningham, of Oklahoma City, has a series of old dislocations of the shoulder irreducible by other closed methods, but readily reducible by skeletal traction identical with that herewith delineated. The hand should not be encased in plaster, for the traction is often great enough to draw the elbow well out and if the hand is not reasonably mobile, it will be injured in extension. It should be held against the upright by a snug, but not tight, bandage or a towel pinned about the forearm. Pulley and weights may be suspended over the out-rigging instead of using rubber if the case seems to require it.



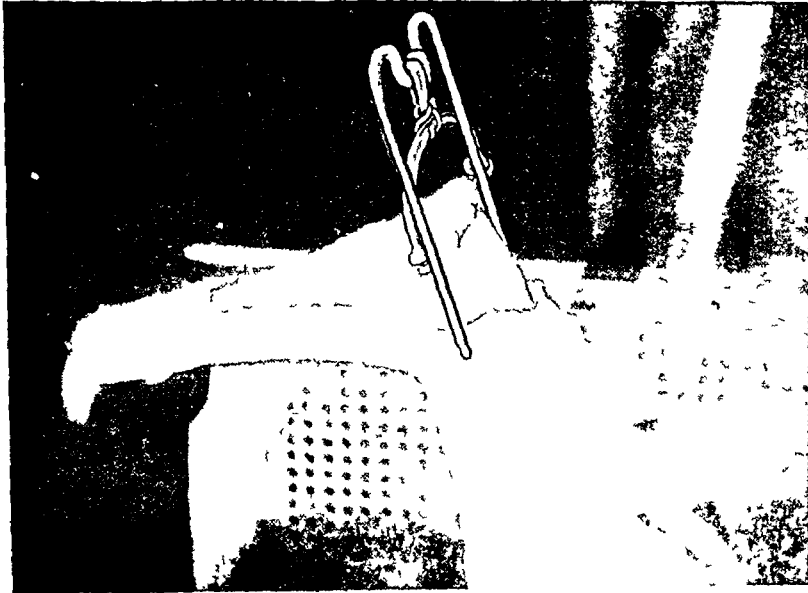


FIG 6

FIG 6—Showing method of extension for fractures or dislocation of the humerus the Kirschner wire passing through the olecranon after method of Dr. S. R. Cunningham. The traction is maintained by rubber bands by a turnbuckle attached to wire extending from the case as shown, or by pulley and weights.

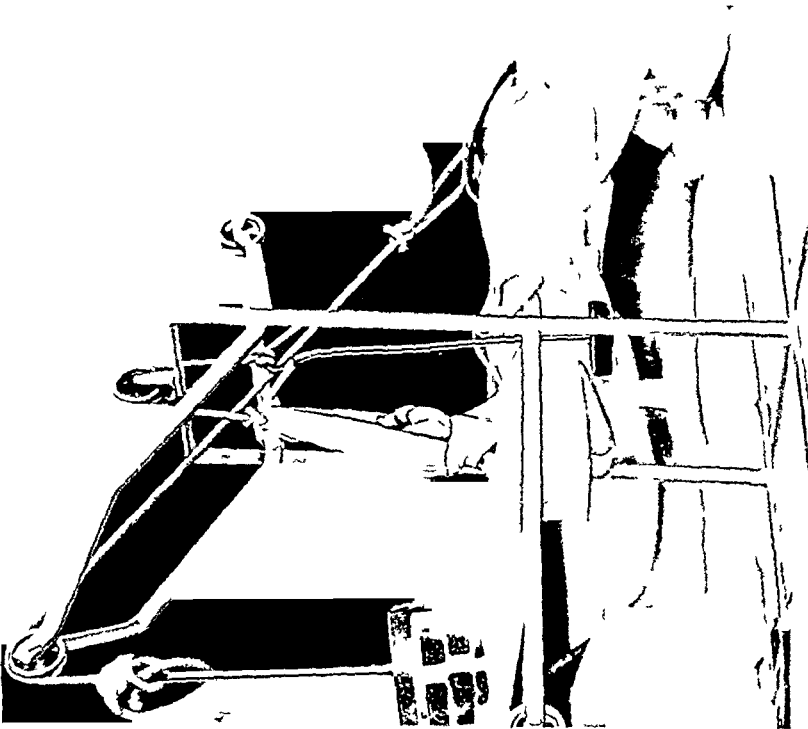


FIG 7

FIG 7—Shows method of applying extension to fractures of the femur (case of Dr. M. W. Pickard). Note that Kirschner wire through condyles is attached to traction cord in line of femur while horizontal extension is also applied to the leg on the Boller frame. It is seldom if ever necessary to use both types of traction in the same individual. Note foot drop prevented by simple overhead cord through pulley fixed to frame.



FIG 8a—Röntgenogram of comminuted fracture of os calcis showing Steinmann pin placed above tuberosity and wire incorporated in plaster case of leg to which extension was attached for downward pull on the bivalved fragments. Note the angle between foot and leg well maintained but position of os calcis not ideal. Reduction under local anesthetic was obligatory.



FIG 8b—Röntgenogram taken of one of the author's cases of fracture of the leg showing Kirschner wire through os calcis and ideal position of foot. Note principle applicable to some os calcis fractures with or without Achilles tenotomy.

# TRANSACTIONS

## OF THE

# PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD MARCH 2, 1931

The President, DR GEORGE P MULLER, in the Chair  
CALVIN M SMITH, JR, M D, Recorder

### PRIMARY CARCINOMA OF THE OESOPHAGUS AND STOMACH

DR HUBLEY R OWEN reported the case of a man, aged sixty-one, who was admitted to the Philadelphia General Hospital August 30, 1930, complaining of difficulty in swallowing solid food. He had pain over his sternum and had lost 30 pounds in the previous three months. In April, 1929, being well, he was severely bruised in an automobile accident. He felt himself becoming gradually weaker but went to work for one month. He was then forced to cease work and was admitted to the Jewish Hospital, complaining also of a broken rib sustained in the accident. He rapidly became very constipated and had some difficulty in swallowing solid foods. He had frequently had regurgitation of food after eating. Röntgenologic examination failed to reveal any gastric lesion but did show an obstruction of the oesophagus at the level of the sixth vertebra.

Examination disclosed no tenderness, rigidity, or palpable abdominal masses. The laboratory examinations were essentially negative.

Oesophagoscopy reported that, beginning thirty centimetres from the incisor teeth, there was an irregular mass springing from the right lateral wall and filling about one-half of the oesophagus. This new growth bled easily to the touch and had the appearance of a malignant tumor.

November 3, 1930, Doctor Owen made a laparotomy exposing the stomach. A chronic infiltrating gastric ulcer about one and a half inches in diameter was found just adjacent to the pylorus, on the lesser curvature. The pylorus, ulcer, and a small amount of neighboring gastric tissue were excised. Billroth No. I operation was performed and a gastrostomy added. Microscopic examination of the specimen removed from the oesophagus by biopsy showed squamous-cell carcinoma.

The patient made a good post-operative recovery in so far as the gastric resection was concerned. After having been fed through the gastrostomy for a few weeks, he was able to swallow liquids. He gradually became weaker, however, and died January 15, 1931. Autopsy was refused.

### INTUSSUSCEPTION OF ILEUM

DR J BERNHARD MENCKE reported the case of a man, thirty-five years of age, who was admitted to the hospital August 21, 1930. Upon the day

swelling was normal in color. It was quite soft to palpation, was not tender, and the inner and outer plates of the bone seemed to be thinned out and slightly expanded. There was no visible or palpable enlargement of the neighboring lymph nodes nor was any enlargement of the bone visible or palpable externally.

The rontgenogram (Fig. 1) showed a cavity in the region of the angle and ramus of the mandible about 3 centimetres in diameter. This extended from the upper to the lower border of the bone and had clearly cut margins. There was some irregularity of the lower margin of the cavity.

The X-ray appearance and the clinical evidence were typical of a cystic condition of dental origin and a provisional diagnosis of adamantinoma was made with also the possibility of benign giant-cell tumor in mind.



FIG. 1.—Rontgenogram showing area in region of left angle of mandible occupied by the tumor.

November 7, 1930, under ether anaesthesia, a curved incision was made in the gum over the swelling and a flap reflected outward to expose the bone cavity. This was found to be filled with rather vascular soft tissue, grayish red in color, quite unlike the dark red of the benign giant-cell tumor. As much of this tissue as possible was scooped out, though it was difficult to be sure of removing all, since the bone was perforated in several

places. The cavity in the bone was packed with gauze and allowed to heal by granulation. The patient made a good recovery and the wound in the mouth healed in about six weeks. It is too early yet to know whether bone regeneration is taking place.

The pathological report by Doctor Case was as follows:

Grossly the only striking feature about these fragments of tissue was their brownish color, suggesting thyroid tissue, though this was not thought of at the time. Microscopically sections from these bits of tissue show thyroid gland tissue with the usual arrangement of acini and stroma. The latter is small in amount, oedematous in some areas, and it carries the blood-vessels which are sufficiently numerous to nourish the tissue satisfactorily.

The acini vary in size, in shape, in the character of their contents, and in the type

## PHILADELPHIA ACADEMY OF SURGERY

(2) Cases in which metastasis of an apparently benign struma contains carcinomatous tissue

(3) Cases in which it is difficult to say from the metastasis whether the struma is benign or not

(4) Cases of metastatic benign tumors in which carcinomatous tissue could not be recognized

The case now reported apparently belongs to the last group

G Blumer (Clinical Manifestations of Tumor Metastases in the Bones, Yale Med Jour, vol VIII, p 153, 1911) states that the thyroid tumors which give rise to bone metastases present some very marked peculiarities. While some of them are very evidently malignant, judged from their clinical manifestations alone, others show none of the ordinary evidences of malignancy. No obvious clinical involvement of the thyroid is present in about 25 per cent of the cases. When enlargement occurs, it is apparently an ordinary goitre which may have been present as long as thirty years before metastasis appeared. It is important to note that metastasis may not appear until three or four years after surgical removal of the gland. According to Blumer, 38 per cent of thyroid bone metastases occur in the bones of the cranium or face. Of the facial metastases, 7 out of 9 were in the lower jaw. We have been unable to find anything significant bearing on this question in the more recent literature.

The possibility that the tissue found in this case is the development of an aberrant thyroid should also be kept in mind, although one can find no reference in the literature to aberrant thyroid tissue forming in bones.

One of the reasons for reporting this case is to emphasize the necessity of bearing in mind the possibility of a thyroid tumor in the mandible when symptoms and signs point to much commoner conditions, such as adamantinoma or benign giant-cell tumor.

### FRACTURES OF THE UPPER JAW AND MALAR BONE

DR ROBERT H IVY and (by invitation) DR LAWRENCE CURTIS read a paper with the above title for which see page 337.

DR GEORGE M DORRANCE said that no two fractures of the superior maxilla are exactly alike, hence there can be no one standardized treatment. The final results must be judged by the occlusion of the teeth. He differs from Doctor Ivy in that he believes that all fractures of the jaw should be reduced as early as possible. Doctor Dorrance finds in his experience, that the majority of cases are best treated by the use of the interdental splint made from a cast of the jaws. He feels that the antrum should be drained in all fractures of the superior maxilla because blood clots or pus pockets are of frequent occurrence there.

DR LAWRENCE CURTIS disagreed with Doctor Dorrance regarding drainage of the antrum. He believes in letting the accessory sinuses alone and has obtained just as good results by so doing. He has never had any trouble from antrum infection, and if trouble does present itself it can be dealt with at that time. Doctor Dorrance said he reduced these fractures immediately. Doctor Curtis also does this if he can, but there are certain cases in which one does not wish to cause any additional pressure. As to the plaster head cap, the speaker uses the one designed by Major Scogin which is not at all uncomfortable. It is made of two layers of stockingette between which there

# PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD APRIL 6, 1931

The President, DR GEORGE P MULLER, in the Chair

CALVIN M SMITH, JR, M D, Recorder

## ACUTE OSTEOMYELITIS IN AN INFANT

DR FREDERICK R ROBBINS reported the case history of a white male child of ten months, who was admitted to the Children's Hospital August 22, 1930. The mother stated that he fell from his bed four days before admission. The next day he became very sick and cross and cried and coughed a great deal. The following day he was apathetic and on the day before admission he vomited three times and his cough continued. Previously the child had been healthy, weight at birth being seven and three-quarter pounds.

Examination revealed a child acutely ill, with a respiratory rate of 45 per minute. The patient's general state gave the impression of a right lobar pneumonia.

On the following day the entire right arm was greatly swollen, hot, painful and indurated, the swelling and tenderness being more marked in forearm and elbow. The left fourth finger also was swollen and tender. The patient was transferred to Doctor Lee's service, with the diagnosis of acute osteomyelitis of the right ulna and left fourth finger. At operation much pus was found under the periosteum of the lower end and in the marrow cavity of the right ulna. The soft tissues of the left fourth finger were also incised and pus obtained. Following the operation, the patient showed signs of severe shock.

On the eighth day the child's general condition was poor. The left upper arm and axilla were swollen and indurated. These were incised and pus obtained. On the eighteenth day the patient continued to lose weight and the wound in the left arm was enlarged. On the twenty-first day incisions were made for multiple abscesses of scalp. General condition was poor. On the twenty-fourth day the outer aspect of the left thigh was swollen and tender. This was incised and much pus evacuated. On the fifty-fourth day the diagnosis of bilateral otitis media was made. Both ears were incised followed by drainage of pus. On the fifty-fifth day the left ear was re-incised. On the sixty-first day the right ear was re-incised and a mastoidectomy was advised by the aurist but was not done because of the patient's condition.

From the sixty-third to the eighty-first day it was necessary to re-incise the right forearm four times.

An X-ray of the entire right ulna now showed changes typical of advanced osteomyelitis with sequestrum formation and marked involucrum formation, also osteomyelitis and pyogenic arthritis of the left fourth finger.

On the one hundred fourth day the X-ray showed infection of the right mastoid. On the one hundred fifth day the patient developed measles and was referred to the Municipal Hospital.

The laboratory findings showed very little secondary anæmia, probably on account of frequent blood transfusions. The leucocytes varied from

## PHILADELPHIA ACADEMY OF SURGERY

CASE II—Normal breast during the menstrual cycle Aged thirty-one, seven days before and seven days after the onset of the menstrual flow, duration of period, four days, one child 1½ years, twins two months, not lactating at the present time Radiographic examination shows the normal breast is at its height of epithelial hyperplasia seven days before the onset of the menstrual flow and at its lowest ebb seven days after the onset of flow The increase in the opacity of the surflike appearance is parallel with the hyperplastic function

CASE III—Normal breast during pregnancy Aged twenty-one, films made seven day before delivery and fourteen months after delivery, two children, no miscarriages, not lactating at present The normal breast during pregnancy shows the same changes in architecture as are seen in the menstrual cycle, only to a far greater degree, for the actual histologic changes are the same as those seen during the menstrual cycle

CASE IV—Aged twenty-eight, ten days following menstruation, duration four days, no children, no miscarriages, not married The films made on this patient show a circumscribed, localized opacity with a definitely defined border The opacity appears to be crowding the linear striations to the side as well as the surrounding breast tissues This is entirely different from the carcinomatous extension, which is by invasion instead of crowding *Radiographic diagnosis*—Benign tumor *Pathologic Diagnosis*—Fibro-adenoma

CASE V—Benign tumor in a male breast Aged sixty-seven, no history of trauma This case clearly demonstrates a sharply defined opacity bordered by a fine line parallel with its circumference, which, no doubt, represents the capsule of the tumor There is also a general tendency to the crowding of the linear striations Axillary and pectoral areas are free from metastatic opacities *Radiographic diagnosis*—Benign encapsulated tumor *Pathologic diagnosis*—Encapsulated fibro-adenoma

CASE VI—Carcinoma with metastasis Aged fifty-eight, two children, no miscarriages, menopause five years ago The radiographic examination of this patient shows the penetrating process of invasion which is so typically noted in malignant tumors, particularly carcinoma There are also a number of small irregular areas of opacity in the vicinity of the pectoral and axillary lymph-nodes These are metastatic malignant nodes

CASE VII—Carcinoma superimposed on abnormal involution with metastasis Aged fifty-three, one child, no miscarriages, menopause one year ago These films show a general irregular appearance throughout both breasts, which is dotted in character These characteristic dotted opacities are typically found in abnormal involution Superimposed on this condition there is also noted an invading opacity in the deeper portion of the breast There are also distinctly localized opacities in the axillary lymph-node area suggesting malignant metastasis *Radiographic diagnosis*—(1) Carcinoma with metastasis (2) Abnormal involution both breasts *Pathologic diagnosis*—(1) Scirrhus carcinoma (2) Abnormal involution

CASE VIII—Calcified axillary lymph-nodes Aged thirty-seven, no children, no miscarriages, not married The lymph-nodes shown in these films are distinctly well defined and intensely opaque, while those of malignant metastasis are very faint and ill defined *Radiographic diagnosis*—Calcified lymph-nodes of tuberculosis

DR J STEWART RODMAN said that any attempt to make diagnosis more exact is certainly praiseworthy Being a surgeon, however, he is not sure but that sometimes X-ray men have somewhat vivid imaginations He does believe, however, that he could follow some of these conditions outlined on the plates by Doctor Seabold The clinical diagnosis of carcinoma of the breast and chronic cystic mastitis is not ordinarily difficult, and therefore until we have X-ray evidence of more positive value we had best go a little slow in accepting evidence which is contrary to clinical findings The most

cures in the operable and border-line cases were 35.6 per cent from operation and 34.9 per cent from irradiation. There was a primary operative mortality of 17.2 per cent and an irradiation mortality of 2 per cent.

The best results that have been reported in this country from the use of irradiation are those of Ward, who obtained a total salvage of 23.1 per cent with five-year cures of cases of stages I and II in 53.1 per cent. Heymann with similar treatment reports a total salvage of 22.4 per cent and in stages I and II, 44.4 per cent. In his own clinic, cautery excision and radium have given a five-year cure in 42.9 per cent, with a total salvage of 13.7 per cent.

DR CHARLES F. NASSAU said that he believed that the use of X-rays across the abdominal cavity is frequently productive of damage. Certainly in the hands of an expert the rays can be directed toward the prostate so that a recurrence can be taken care of but on at least two occasions the speaker has seen extensive adhesions of the bowel following this treatment in cancer of the uterus. In operations for obstruction of the bowels after X-ray treatment of the uterus it is practically impossible to separate the adherent coils of intestine. One patient recently operated upon in this city went to a roentgenologist of her own volition. She was having bleeding from the uterus and it was supposed that she had cancer, perhaps she did. Later she came to Philadelphia and went to another who continued the treatments. She was finally operated upon for obstruction and the surgeon spent two hours trying to relieve the adhesions and did not succeed.

DR JOHN B. DEEVER remarked that the important point is to get the cases early and particularly those with laceration and erosion of the cervix, *etc.* The treatment is too often determined by the roentgenologist and the family doctor, rather than by the experienced surgeon or the gynecologist, who should be much better able to decide the question of surgery or radiation. Even surgeons of long experience find difficulties sometimes in determining the line of treatment to pursue. The general impression held by the laity that radium and X-ray will cure carcinoma is wrong. Only certain types of carcinoma are amenable to radium and X-ray and the truth should be given the laity. However, enthusiasm is sometimes not tinged with the best judgment.

#### CHOLECYSTOSTOMY, ITS INDICATIONS AND RESULTS

DR E. L. ELIASON and (by invitation) DR L. K. FERGUSON read a paper with the above title for which see page 370.



tatic growths appearing in many parts of the body, there was considerable involvement of the right clavicle, and multiple tumors in the scalp, cranial bones and cervical vertebræ. About this time the maximum growth of the tumor in the stump was attained, the circumference was thirty-one inches (an increase of fourteen inches since January 22). The end of the stump had broken down over an area of five inches in diameter, from which there was a profuse, foul, and ichorous discharge.

August 5, 1926, Coley's toxins were again begun, the dose of 2 minims was increased daily by 1 minim until 17 minims were reached. This was given daily until September 4. By this time the improvement was very marked. The stump was much smaller, the supra-umbilical mass had practically disappeared, the areas of involvement of the scalp had disappeared, and the clavicular tumor had decreased considerably in size.

An additional series of toxin injections was begun on September 19 and continued for three weeks. On November 22, the general condition of the patient was excellent, his weight was 147 pounds, a gain of 30 pounds since January 22, the stump was seventeen inches in circumference, a reduction of 14 inches since May. The old wound of the stump had entirely healed, the growths of the abdomen, groin and scalp had disappeared, and the right clavicle showed only some degree of thickening and roughening. The patient was discharged from the hospital December 5, 1926, apparently entirely well.

In February, 1927, he received further treatment with the toxins, a dose of 3 minims increased every third day until he was getting 30 minims.

After the case was published in July, 1927, a still further series of injections was done in October, 1927. He has remained in excellent health ever since and has had no evidence of the disease either in the bones or soft parts. It is now more than five years since the treatment was begun.

DOCTOR COLEY said that in view of the remarkable recovery, the pathology of the tumor has aroused a good deal of interest. The case has been classified by the Bone Sarcoma Registry committee (Case No. 1143) as a Ewing's sarcoma. The microscopic sections have been examined by a number of pathologists. Regardless of the diversity of opinion as to the classification of this tumor, all agree that it is a highly malignant tumor. No matter what the classification is, there is no doubt that they were dealing with a highly malignant tumor with numerous metastases to both bone and soft parts, which has been cured by Coley's toxins alone without any other form of treatment.

#### ENDOTHELIAL MYELOMA OF THE FIBULA, METASTASES AMPUTATION TOXINS FOR THREE MONTHS PERMANENT RECOVERY

DOCTOR COLEY presented a youth who, at the age of eight years, was admitted to the Hospital for Ruptured and Crippled in March, 1920. He had always been well until January, 1920, when he received a severe blow on the outer side of the right leg. Shortly after he began to have pain in the leg, and a few days later a swelling developed which increased rapidly in size. An exploratory operation showed some pus and marked thickening of the bone, this was extensively curetted. The tumor grew very rapidly after the operation, and became fungating. Doctor Coley saw the patient for the first time in June, 1920, when there was a large tumor occupying the lower two-thirds of the fibula, fungating over the central portion. The glands of the groin were markedly enlarged.

Amputation was performed by Dr. Armitage Whitman in June, 1920, immediately after which the toxin treatment was started. The pathologic diag-

This case shows that it is possible to cure a very extensive giant-cell tumor of a long bone even after the bony shell and a considerable portion of the bone have been destroyed, and that it is possible to accomplish this with a much shorter period of disability than is ordinarily required for treatment by radiation. Furthermore, this and a number of similar cases treated by toxins alone prove that resection of the bone, as advocated by Bloodgood and others, in the treatment of giant-cell tumors, is entirely unnecessary, for once the disease is cured or eradicated, practically complete regeneration of bone follows with full restoration of function.

DOCTOR COLEY said that he presented these cases that evening because, so far as he knew, there were no cases in medical literature comparable to them, that have been successfully treated by any other method of treatment. Other recoveries under the toxins, quite as remarkable as these, could be cited.

He hoped that the end-results obtained might be sufficiently convincing to cause a much wider use of the method, not only in inoperable metastatic bone sarcoma but in the earlier stages of the disease when it is possible to save the limb as well as the life of the patient. In the first case presented this evening, the Marine Hospital case, the limb in all probability might have been saved had the toxins been used before amputation.

It should be clearly understood that he did not advocate the use of the toxins in all cases of bone sarcoma. They had learned by long experience that in the osteogenic type, with much new bone formation, neither toxins nor radiation have a marked effect. If such cases are treated by conservative methods one not only fails to save the limb but greatly lessens the chances of saving the life by the delay incident to such treatment. These cases should have immediate amputation followed by prolonged prophylactic toxin treatment. This method, in his experience, had resulted in about 50 per cent five-year recoveries.

It is the highly cellular bone tumors of the osteolytic type, with little new bone production, the endothelial myelomas or Ewing sarcomas, that afford the most promising field for the use of Coley's toxins, furthermore, these tumors are highly radiosensitive. This would, theoretically, seem to justify the use of the combined method of treatment, *i e*, toxins and radiation. A recent analysis of eighty-six cases of this type observed at the Memorial and the Hospital for Ruptured and Crippled shows twenty-two alive and well beyond the five-year period. Only one case recovered under radiation alone although primary radiation was employed in no less than thirty-four cases.

In spite of these superior results following the use of Coley's toxins, most of the recent literature on bone sarcoma omits any mention of the method. The poor results of surgery have been stressed so much that there is at present a growing tendency to treat all types of bone sarcoma by radiation, and this in spite of the fact that few of the men who are using this method have any idea of the end-results of such treatment. He believed the Memorial Hospital to be the only hospital that has treated a sufficiently large number of cases of operable sarcoma of the long bones by radiation, with a careful fol-

DR ALLAN O WHIPPLE said that the cases in which the serum has been used at the Medical Centre had not responded to the treatment. In using the fluid, if the patient shows no evidence of response to the ordinary dosage, should it be increased notwithstanding the patient's marked reaction? Also, whether in the Ewing type of tumor with metastasis would one be justified in pushing the dose to the same point as was done in the case treated at the Marine Hospital?

DR BURTON J LEE explained that Doctor Coley, in stating that radiation had been given up at the Memorial Hospital, referred to the osteogenic sarcomas, not the endothelial myelomas which are highly radiosensitive and respond very well to radiation.

DR COLEY, in closing the discussion, stated that the toxins were bacterial rather than chemical in composition.

The susceptibility of the patients to the toxins varies greatly. For this reason he advocates a very small initial dose, not over one-half minim, injected intramuscularly, and increasing by one-half minim, or, if the patient is not very susceptible, by one minim a day, up to the point of producing a reaction of  $102^{\circ}$ - $104^{\circ}$  F. The dosage may be estimated accurately by diluting the toxins with a little freshly boiled water. The temperature is the guide to the dosage. In his early work, Doctor Coley used local injections made directly into the tumor itself, but later on he substituted the intramuscular injections. During the last three or four years Dr Bradley L. Coley and he himself have been using intravenous injections in a number of cases, and with, apparently, improved results over the intramuscular. He was not prepared to advocate the intravenous injections as a routine measure. At any rate, the patient's susceptibility should always be tested first by intramuscular injections. For the intravenous it is necessary to begin with a much smaller dose, not over 1/100 minim, diluted with sterile saline solution, if no reaction follows, use 1/90, then 1/80 minim and so on, until the desired reaction has been obtained. The temperature usually rises to  $103^{\circ}$ - $104^{\circ}$  after the first intravenous injection. However, the patient's susceptibility rapidly diminishes, and after six months' treatment Doctor Coley has given as high as 30 minims intravenously.

As to the period of time covered by the treatment, Doctor Coley stated that no definite rules could be laid down that would apply to all cases. The case of Doctor Lilienthal, referred to this evening, with extensive involvement of the spine, ribs and mediastinum associated with complete paraplegia, recovered under only eleven doses of toxins. Doctor Coley believed it better to err on the side of giving the treatment too long rather than stopping too soon. In the Marine Hospital case (first patient presented this evening) the treatment was given by men who had had no previous experience with it. This, and many other cases, he believed, answered the criticism that he was the only one who could get results with the toxins.

Since this time, nearly one year and nine months ago, the wound has remained solidly healed, the scar slowly retracting, and the patient has been gradually improving in health and gaining in weight, despite the fact that the pneumothorax has persisted. January 14, 1930, and February 18, 1930, X-ray examinations showed the right lung to be much clearer and a definite accumulation of fluid with a distinct level at the bottom of the pneumothorax cavity. The inner pleural wall has increased considerably in thickness. Presumably the fluid in the cavity was sterile as the patient had no fever, although at this time she complained of pain in her right chest and also of violent attacks of coughing, especially when she lay on her left side, but there was no expectoration. These symptoms, which were probably due to the irritation from the accumulated fluid, disappeared within a few months for seemingly no special reason except, perhaps, because of the spontaneous absorption of the fluid. Since then she has been perfectly well.

Her last examination was made January 6, 1931, by Dr. James Alexander Miller, who reports the condition of her right lung very satisfactory, although the X-ray examination still shows the pneumothorax in the upper, outer third of the chest. The cavity is somewhat smaller than on the previous examination and does not contain the fluid that was noted at that time. The thickening of the pleura on the inner wall has increased slightly and one fibrous band running obliquely across the cavity stands out prominently. The partially expanded right lung is quite well aerated. The fluid has presumably been absorbed, but evidently the rigidity of the walls of the pneumothorax has prevented the expansion of the lung and the absorption of the air.

This case demonstrates that an empyæma cavity can apparently become sterile and heal permanently in spite of a persistent post-operative pneumothorax and is presented because its course is completely at variance with the usual conception of the mechanism involved in the healing of an empyæma cavity. The general impression has always been that an empyæma cavity can only close with expansion of the lung and obliteration of the space between the surface of the lung and the thoracic wall. Where the lung cannot fully expand, due to cicatrization and rigidity of the visceral pleura, it has always been assumed that the residual cavity must fill in by granulation, or, if that is not possible because of its shape or size, then a more or less extensive thoracoplasty to collapse the chest-wall, or a decortication of the lung, or both, were necessary.

During the war, Carrel advocated the Dakinization of the empyæma cavity, freshening of the wound edges, and closure of the thoracic wall by suture when the cultures from the cavity had become sterile. During the influenza epidemic of 1918, the speaker experimented with this procedure at United States Army General Hospital No. 1 at Williamsbridge, New York, and he had an occasional success, the wounds healing by primary union and remaining closed, the air of the pneumothorax being promptly absorbed and the lung expanding. These successes, however, occurred only in a very special type of case—namely, in a streptococcus infection, with a rather acute, recent empyæma, with a relatively thin, seropurulent exudate, and with comparatively slight changes in the pleura. Doctor Stetten's feeling at the time was that the only cases in which one could hope for success were cases where either one or more simple aspirations might have accomplished the same result. He never saw a satisfactory result from this procedure in the pneumococcus infections, with a thick, creamy, purulent exudate, with masses of fibrin, and with any degree of pleuritic infiltration.

to the patient so far inasmuch as it has helped to obliterate the existing bronchiectatic cavities

DR ALEXIS V MOSCHCOWITZ stated that he had seen a number of cases of empyæma which healed and which remained healed with a pneumothorax. He originally made this observation during his service on the Empyæma Commission during the war and he had explained in previous articles the definite healing of the empyæma cavity by absorption and rarefaction of the air within the pneumothorax and subsequent expansion of the lung.

DR CARL EGGERS said that ordinarily one should not consider an empyæma healed until the cavity has been completely obliterated. The lung has to be re-expanded and form contact with the parietal pleura. Usually this takes place as healing progresses. Sterilization of the cavity and obliteration go hand in hand.

Occasionally, however, one finds a patient in whom the outer opening closes before the lung has fully expanded. If in such a case infection is still harbored within, recurrence will develop, but if the cavity is superficially sterile the patient may get well that way. Doctor Stetten's patient evidently belongs to this group.

Great interest attaches to the reason for the non-expansion of the lung in these cases. A lung expands as soon as an exudate has been evacuated unless dense adhesions bind it down. Even in pneumothorax treatment of pulmonary tuberculosis constant refills are necessary to keep the lung compressed. What, then, is the difference between the usual empyæma cases and those in whom the lung fails to re-expand? One must differentiate between lung compression and lung collapse. In the ordinary empyæma and in artificial pneumothorax pressure is made on a lung with an intact covering. In such a lung the normal mechanism tending to expansion is operative. If, however, a perforation through the visceral pleura is present, such as one finds as the result of perforation of a lung abscess, the lung collapses and the normal respiratory mechanism for that lung is changed. In such a collapsed lung fibrous tissue changes may take place, interfering with normal re-expansion even if the perforation eventually closes. The usual treatment required in this type of a case is some form of thoracoplasty.

Doctor Eggers then showed slides of a case in which healing had also taken place in the presence of a large cavity. The patient was admitted seven years ago with an acute pyo-pneumothorax. There was considerable tension within the chest and with the patient lying on the side a fluid level was visible. After prolonged drainage and treatment by the Carrel-Dakin method, the cavity became sterile but the lung failed to re-expand. Healing took place, nevertheless, and the patient has remained well.

DR EDWIN BEER agreed with Doctor Moschcowitz as to the two methods of healing empyæmata. He was under the impression that healing took place with the formation of pneumothorax, as illustrated by Doctor Stetten's case,

that there is a great variation in the susceptibility of different cancers to irradiation, from the anaplastic cell types to the more highly differentiated tumors, and in those that approach the normal structures closely, clinically and histologically, it would be illogical to expect a considerable difference between the tumor and the normal tissue in the reaction to irradiation. So it is not surprising to note that some cancers are wholly resistant from the beginning and that in others the first favorable effect of irradiation upon the tumor is often followed, sooner or later, by a progressive cancer growth which is wholly resistant to further irradiation. Corollary to this is the observation that cancer tissue that persists after irradiation may grow and infiltrate less rapidly than untreated cancers or those recurrent after operation. This is less a consequence of destructive changes in the cancer cells than of the fibrosis and the sclerosed blood-vessels in the field in which they lie, *i e*, a simple expression of poor nutrition. The two primary cases presented by Doctor Adair illustrate both of these points very well. Though apparently well clinically, these patients still have active cancer cells in the breast, as shown in the biopsy examination, and they have not been cured, but the cancer foci have given no other evidence of their presence for six years, and in this unfavorable soil the apparent latency may continue.

The diagnosis of cancer of the breast from clinical findings alone without microscopic examination may be fairly dependable in typical cases, but experience and laboratory records have shown many errors. L. Duncan Bulkley, in his book "Cancer of the Breast," collected 250 cases from his private practice, in nearly all of which the diagnosis of cancer had been made by "competent physicians and surgeons", but many of the tumors had disappeared spontaneously under the treatment by diet alone, and obviously these were not cancers. For statistical purposes, therefore, purely clinical diagnoses of breast cancer have a doubtful value, and it is misleading to contrast, in table form, the end-results of the irradiation treatment of such cases with the results of radical surgery in histologically proven cancer cases. He was in full agreement with Doctor Adair, however, in considering biopsy a dangerous procedure in breast cancer.

In tabulating the end-results of the radical operation for cancer of the breast, it is considered a surgical failure if the patient has died from cancer. In fairness to surgery, it should be noted whether the cancer death was caused by a recurrence, local or regional, or by a distant metastasis without local or regional recurrence. Comparative tables for irradiation *versus* surgical treatment, then, should deal primarily with such local or regional cancer persistence alone. Following a comprehensive operation, recurrences at the site of the breast or in the regional lymph-nodes are infrequent, and the late fatalities are usually due to metastases chiefly in the lungs or the bones, and to a less extent, in the liver and other organs. The underlying histologic reason for this, apart from the lymphatic transit to the blood-stream, lies in the presence of invading cancer cells in the small veins, and this constitutes a weak spot in the treatment of this disease. It has been repeatedly recorded in the

The patient, following operation, continued a tendency to looseness of the bowels which has been helped by including 2 or 3 bananas a day in his diet.

Doctor Smith presented also a woman, sixty years of age, who was admitted to St. Luke's Hospital in February, 1920. The chief complaint was rectal bleeding. For four months there had been increasing constipation, weakness and loss of appetite, for the past month pain and bleeding from supposed hemorrhoids. Just within the anal sphincter on the posterior and lateral wall there was an ulcerating tumor about  $2\frac{1}{2}$  centimetres in diameter. It was movable. An operation was planned more as a palliative procedure than with the hope of cure. A left inguinal colostomy and a perineal excision of the rectum with suture of the amputated end of the bowel to the perineal skin was carried out. The pathologic report states that the growth was continuous with the mucocutaneous margin, that it occupied almost the entire length of the section there being less than 1 centimetre of normal mucosa above and that it involved the entire muscle coat. The diagnosis was carcinoma of the rectum, squamous-cell type. The patient made an uneventful convalescence and was discharged on the twenty-third day.



FIG. 1.—Polyposis of rectum and sigmoid with carcinomatous ulcer.

She has remained under observation in the follow-up clinic since and up to date, more than eleven years, there has been no recurrence found.

The case demonstrates that in selected cases when the radical operation is contraindicated a more conservative procedure may be well worth while.

DR FRANK S. MATHEWS recalled a case of carcinoma involving the anal sphincter which has remained well for six years, and which was treated somewhat like Doctor Smith's case. The operation was entirely through the perineum. The proximal bowel was sutured to the skin but at a later time, because of the absence of sphincter, a very extensive prolapse of rectum occurred which requires a T-bandage for its partial control. The patient declines any suggestion of operative relief.

DR JOHN DOUGLAS said that he had had two cases of squamous-cell epithelioma of the rectum near the anal margin. The first one was operated on more than two years ago by a complete local excision of the tumor and microscopic examination revealed carcinoma. More radical operation was advised and refused. The patient has remained well ever since with merely this local excision and radiotherapy. The other patient, an old woman, was

freely movable, not attached to the skin, but connected with underlying structures. It feels elastic or cystic, not tender. No palpable nodes are present in the neck, except two in the right submaxillary region. The right lobe of the thyroid is enlarged, and there is a separate nodule corresponding to the isthmus.

Under intranasal ether, operative removal of the mass in the left side of the neck was made August 15, 1930. There was found a rounded, lobulated tumor some 4 centimetres in diameter and about 2 centimetres thick. It was encapsulated and lobulated. It felt soft and the cut surface had a yellowish mottled appearance almost like liquefaction-necrosis. As the upper anterior portion of the tumor was dissected, two or three drops of what looked like pus appeared, but no abscess cavity was found, this liquefaction being due to degeneration of epithelial cells often seen in neoplasm of branchiogenic origin.

The report on the tissue from the surgical pathology laboratory was as follows:

A composite tumor of the parotid consists of a tumor mass measuring 4 by 3.5 centimetres. It is entirely covered by a thin connective tissue capsule except where it has been cut open. It is roughly oval and its surface shows a few small lobulations. It is firm and resilient to palpation. Upon section the cut surface is muddy gray and contains several somewhat yellowish areas scattered throughout. At one margin there are numerous ecchymoses. The cut surface is not extremely hard. No mucinous areas can be seen. Microscopic sections show an unusual picture. The bulk of the mass is composed of lymphoid tissue containing large germinal centres. Running throughout all the lymphoid tissue there are numerous large alveolar spaces lined by three or four layers of pale, cuboidal or polyhedral epithelial cells that are very uniform in size, shape, and staining qualities and which show no mitotic figures. Their cytoplasm is very finely granular, and they have rounded or oval vesicular nuclei and often contain distinct nucleoli. In the cells immediately bordering the lumen many of the nuclei tend to be hyperchromatic. Within the alveoli there are large masses of granular debris, desquamated epithelial cells and numerous cholesterol crystals. The epithelial cells have clear-cut basement membranes, and in no place do the cells appear to be actually invading or infiltrating the lymphoid tissue. The shapes of the alveoli are not markedly irregular but are rounded, oval, or dumb-bell in shape. In some areas there are papillary projections of this same epithelium extending into the lumen and in these the epithelium rests upon delicate connective tissue stalks or are broader and more club-like and their bulk is made up of lymphoid tissue and their centres frequently contain germinal centres. A section of the lymph-gland removed from the outer surface of the tumor mass shows nothing unusual. A small fragment of parotid salivary tissue is attached to one margin. This is an extremely rare tumor and most closely resembles the branchiogenic adenomas described by Lubarsch. These are due to embryologic rests resulting from a pinching-off of portions of the early oral epithelium and mesenchyme. This does not have the appearance of a malignant tumor or of a metastasis from a malignant tumor.

When seen two and seven months after operation the neck was apparently cured of the original disease. No enlarged nodes were felt. There was slight diffuse enlargement of the thyroid gland.

DOCTOR HANFORD presented also a man, forty-five years of age, who first came to the Presbyterian Hospital in January, 1931, with a large swelling in the left side of the neck, but otherwise well and doing his usual work. Five years previously he had first noticed a small lump in the same side of the neck—the size of a marble. It felt hard and movable. It had gradually increased to the size of a goose egg. About three years ago the mass was removed at an out-of-town hospital. Tonsillectomy was done at the same



This is rather a poorly differentiated squamous-cell epithelioma, apparently branchiogenic in origin and differs from the biopsy sections removed several years ago in that it contains at the present time almost entirely epithelial elements rather than epithelial and lymphoid elements as seen previously. It seems to be a rather slow-growing tumor but the metastasis in the lymph-glands would indicate that the prognosis was not good.

This is an exceptionally rare sequel of tumors of branchiogenic origin and to predict the rapidity of its course would be extremely hazardous.

*Diagnosis*—Squamous-cell epithelioma (branchiogenic type) of lateral neck region with metastases to cervical lymph-glands.

This patient was presented because of the unusual finding of branchiogenic adenoma which apparently gave rise to a squamous-cell epithelioma—rarely seen in branchiogenic tissue.

It is important, as a general rule, to remove early all neck tumors no matter how innocent in appearance.

## TUBERCULOSIS OF THE CERVICAL AND AXILLARY LYMPH-NODES WITH ERYTHEMA INDURATUM OF THE LEGS

DR JOHN M. HANFORD presented a young woman, eighteen years of age, who first had enlarged nodes in the neck at the age of eight years. She came in March, 1924 at the age of eleven, to the Presbyterian Hospital with numerous lesions in the left side of the neck—an abscess, a sinus, and several firm nodes, evidently tuberculous. The lungs were considered clear except for enlarged hilar regions shown in the chest X-rays. There was a slight anæmia. The tonsils and adenoids were enlarged.

She was treated first by excision of the disease in the upper part of the neck. The tissue proved to be tuberculous. Nine days later the tonsils were removed and showed on tissue examination only chronic tonsillitis. Five days later she was discharged from the ward in good general condition, but with enlarged supraclavicular nodes, an unhealed wound in the left side of the neck, and enlarged left axillary nodes recently noticed.

At the age of fifteen after seven years of continuous lymph-node tuberculosis there was a new flare of disease in the neck with erythema induration of the tuberculous (Bazin's disease or papulo-necrotic tuberculide) type, the typical lesions of which appeared on the legs. Five months later, five years after our first treatment, she was in good condition, but still showed disease in the right side of the neck, and the leg lesions, which now were troublesome.

By last August the legs were much better and the neck and axilla were apparently healed. At the end of a summer of sunshine and rest, and good hygiene, she was practically well, only to suffer severe reactivity in the right neck and in the legs. In December last she was readmitted to the hospital. After improving her general resistance a radical right neck dissection and removal of a caseous left-node was made under avertin and intra-nasal ether anaesthesia. Enlarged nodes, a sinus, and a cold abscess were excised, and showed tuberculosis in a tissue examination. A biopsy was made from one of the leg ulcers on the lower calf, and the dermatologic laboratory reported their histologic diagnosis to be papulo-necrotic tuberculide. The blood Wassermann was negative.

She was again operated on in early February, 1931 to remove the last vestige of active apparent lymph-node disease. This was in the right axilla from which tuberculous nodes were cleaned out February 6.

In the follow-up clinic, two weeks ago, the general condition was excel-

pulsation of the left globe was felt on deep pressure—no visible pulsation. The blood pressure was 170/100, the pulse about 70. There have not been any signs of cerebrospinal lues. The patient has been said to be hypersensitive to Salvarsan. The general physical examination was essentially normal. A few hyalin casts were found in the urine, the blood Wassermann was strongly positive. Röntgen-ray studies of the skull showed nothing abnormal, both in November, 1930, and in March, 1931. It was assumed there was a fracture of the base, not detected.

Digital compression of the left common carotid artery stopped the subjective and objective bruit. If continued for two minutes he felt numbness and weakness in the right extremities.

The treatment, started in late November, consisted mainly of digital compression of the left common carotid artery, followed December 12 by partial occlusion of the left internal carotid artery. The compression was made three or four times daily, mostly by the patient, though supervised by a nurse. The period was slowly increased from two to fifteen minutes at a time.

The occlusion was done under regional anaesthesia. A Matas-Allen aluminum band was applied to the artery so that the bruit was barely heard over the left globe. The patient began to improve in every way. The next day no bruit at all was detected. He felt better than at any time since the accident. The eyes greatly improved in every way. He was kept quiet in bed. On the ninth day after the operation he developed within a few hours (the details are not known) a complete hemiplegia affecting the right side and involving the speech centre so that he was completely aphasic.

Various types of physical therapy were begun soon after this accident and he has recovered enough to walk and to make himself understood.

He left the hospital January 24 with no subjective or objective bruit, no pulsation of the globes, no retinal hæmorrhages, slight vascular congestion, and with exophthalmometric readings of 24.5 in the right eye and 25.5 in the left.

By the middle of February he began to detect the bruit starting in the ear, and it became audible with the stethoscope, loudest over the left globe, and also quite loud in the neck, just above the recent operation scar. All of the pre-operative eye findings returned. Blood pressure was 175/100. It was evident that the aneurism had recurred and that its course would be progressively worse. He was readmitted to the hospital February 26.

It had been planned at the start to follow the partial occlusion by a complete occlusion of the artery at a second operation, and, at the second time, to ligate the left internal jugular vein. The partial occlusion evidently became complete spontaneously and caused the hemiplegia from softening of the left cerebral hemisphere due to inadequate blood supply. It was decided, therefore, at the second operation, to ligate the vein, which was done March 23. The internal carotid artery was found completely occluded. No cause for the bruit heard in the neck was found. The vein was smaller rather than larger than usual.

Since the vein ligation, the bruit is less loud but still present, loudest over the left globe and in the left side of the neck. But the bruit cannot be eliminated by digital compression anywhere—not even of the right common carotid artery. It is doubtful, therefore, whether a right carotid occlusion would be helpful even if it were safe.

He now presents a right hemiplegia with motor aphasia, with partial recovery, a persisting arterio-venous communication with symptoms improved

the fracture site becomes painful and tender and remains so for a while, to subside on rest

Film of the right lower leg in stereoscopic views reveals the presence of an old fracture at the junction of the middle and lower thirds of the tibia and fibula. There has been a considerable amount of bone production about the fracture line of the tibia, but nothing is present to suggest bone union. The fracture line is still sharply outlined. It is possible there is fibrous union but one is unable to see it on the films. There is slight overriding of the fragments of the fibula and no attempt at callus formation about the ends of the fragments. The bone about the ankle shows marked decalcification apparently due to disuse. There was slight angulation at the fracture site, very slight mobility, considerable tenderness, and pain on the demonstration of the slight mobility.

March 24 1930, Doctor Bull exposed the site of fracture by incision, 15 centimetres. The tibia was enlarged, twice its normal diameter, mainly anteromesially. The line of fracture was clearly demonstrated and the union seemed to be fibrous. The sinus track on skin led to a small abscess containing a split-pea-sized sequestrum on anterior cortex at the anterior edge of the bone. The infected bone was apparently confined to an area measuring 3 centimetres in diameter. Tissue in medullary cavity appeared normal. The overlying skin was excised and the bone removed by chisel to leave an anteromesial and posterior shell. The resulting saucer measured 3.5 centimeters in depth and width and 12 centimetres in its greatest length. The cavity was packed with Mikulicz tampon of vaseline gauze, and a plaster-of-Paris circular splint applied to include lower third of thigh and foot.

The next day, through a window cut in this plaster exposing the bone cavity, the vaseline gauze was removed, the wound surface made to bleed throughout by rubbing with gauze, and the blood-filled cavity packed with sterile-powdered chemically pure calcium carbonate and triple calcium phosphate in proportions of one and three. The powder was well mixed with the blood in the cavity, and filled the whole cavity to the skin surface. It was covered by vaseline gauze and the window replaced in the plaster.

The cavity was inspected two weeks after placing of the calcium, and note made that the cavity was filled to half its depth with firm granulation tissue containing numerous areas of whitish discoloration due to presence of calcium in the tissue.

A new plaster casing was applied. This was removed on May 3, five and a half weeks after placing calcium, and the wound was found completely filled with the same type of tissue, which was actually exuberant above the skin level. Adhesive strapping was applied to aid in the epithelization of the granulating area. On May 7 he was discharged with clinically solid union, and with no splints, six weeks after placing the calcium. X-ray one month later showed firm bony union through the shaft of the tibia. The picture shows no evidence of the cavity that was created at operation. Subsequently the skin scar required some surgical attention, and there are some minor static troubles due to a slight angulation. Twenty weeks after the original operation the patient was driving a car without any difficulty. At nine weeks the patient was walking on a leg brace, at fourteen weeks without brace except for protection in street. At sixteen weeks he was without brace support. Bony union was present at six weeks and cure of the osteomyelitis and obliteration of the operative defect 12 by 3.5 by 3.5 centimetres was present at twelve weeks, despite the fact that the operative procedure for the cure of a low-grade osteomyelitis and non-union embodied the removal of a great deal of bone as the essential procedure.

CASE II—Male, aged twenty-six years, admitted to the Fracture Service of Presbyterian Hospital, October 20, 1930, eight weeks before admission sustained a compound fracture, with comminution in the mid-portion of the tibia. This was reduced under anaesthesia at another hospital and placed in circular plaster, with a window through which dressings were done for the compounding wound. Has been on crutches with slight weight-bearing on plaster since.

## NEW YORK SURGICAL SOCIETY

### DELAYED AND NON-UNION IN FRACTURES IN THE ADULT

DR CLAY RAY MURRAY then read a paper with the above title for which see page 961, vol xciii, May, 1931

DR WILLIAM DARRACH said that this series of experimental investigations, both clinical and laboratory, is of special interest because it presents a different point of view. Previously, in trying to do something for these discouraging cases of delayed or non-union, the speaker had a mental picture of something that would bring the ends of the bone together so that the ends of the bones would heal. He now had a different point of view, that is, to bring the ends of the bone in such apposition that granulation tissue could form from the soft parts to form new bone. Doctor Darrach agreed with Doctor Murray that the source of new tissue which unites the ends of broken bones takes on the character of granulation tissue and goes into the stage of calcification and ossification. This point of view will probably effect considerable change in future technic. Some of Doctor Murray's cases have shown astonishing results. In the early stage of granulation tissue they present a picture of healthy red granulations but they are hard rather than soft. The way the cavity fills in is very encouraging. The only new thing about this treatment is the introduction of artificial calcium as a source for new bone formation, for the rest of the treatment is the same as the Orr treatment which is safe and sound if all the points are observed.

DR SEWARD ERDMAN said that while the conception of new bone formation as brought out by Doctor Murray was interesting he could not see that it is the only way to bring about bony union. Two years ago, Doctor Pascal, of the Neckar Hospital in Paris, gave a talk at the French Hospital in which he showed some slides illustrating a method which he had found successful for fractures of the tibia. He used a metal collar from four to six inches wide which he placed about the fractured bone beginning just above the malleoli and reaching pretty well up the tibia. It took the place of external splints. According to Doctor Murray's theory, this should have deprived the bone of granulation tissue which is supposed to come from the muscle and yet Doctor Pascal reported prompt and astonishing results.

These metal collars of Pascal had some fenestrations—to permit fastening—as in the Parhan bands, but Dr H H M Lyle, who discussed the matter with Doctor Pascal, states that Pascal claimed the same good results when solid metal collars were used.

If this be true, Doctor Murray's theory would not appear to explain all cases.

DR JOHN J MOORHEAD remarked upon the apparent ease of obtaining union by the introduction of the calcium preparations. Other things had been used with the same idea in view, such as egg-shell and sea-shell. There were certain theoretical objections to the procedure because foreign bodies were introduced and in bone work particularly it had been found that auto-

## BRIEF COMMUNICATIONS

### THE ABDUCTION METHOD CONSIDERED AS A STANDARD ROUTINE IN THE TREATMENT OF FRACTURE OF THE NECK OF THE FEMUR

Now that a method is at command which is adequate to assure the primary essentials of success, it has been demonstrated that union of the intracapsular fracture, once considered a remote possibility, may be attained in the majority of cases, the only debatable question being of percentage of the cases in which there is an actual incapacity for repair. The latest statistics compiled by Reggio give the results in forty-nine cases treated by the

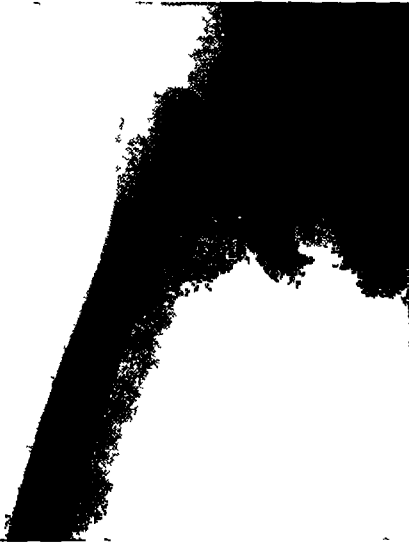


FIG 1



FIG 2

FIG 1—A typical transcervical fracture  
FIG 2—Taken through the plaster showing the ineffective application of the abduction method. The prominent trochanter minor indicating outward rotation of the proximal fragment.

abduction method at the Massachusetts General Hospital. The patients were of an unfavorable type, 59 per cent being over seventy years of age. Yet union was attained in 66 per cent of the cases in which the treatment was carried to a conclusion. (*Journal of Bone and Joint Surgery*, October, 1930.)

This presents a striking contrast to the results recently reported from the Charity Hospital at Berlin of 136 cases treated by conventional methods in which there was union in but 6 per cent. (*Archiv f Orth u infall Chir*, May, 1930.)

Doctor Reggio, in comparing reports on the abduction treatment, finds it difficult to reconcile the discrepancies, bony union varying from 50 to 90 per cent and the rate of mortality from 5 to 29 per cent. It would seem that the most reasonable explanations are the selection of cases and the relative efficiency of the treatment. Formerly transcervical fractures in

when it is officially conceded that fracture at the hip is amenable to the rules that govern the treatment of other fractures and entitled therefore to the same protection, there can be no alternative to the treatment that has made the common standard practicable. For with this means at command one who cannot present evidence that he has made success possible will be held responsible for failure.

ROYAL WHITMAN, M D,  
New York, N Y

### BASAL CELL CARCINOMA OF THE PENIS\*

IN A recent study of fifty cases of *epidermoid* carcinoma of the penis, Colby and Smith (Jour Urology, vol xxv, No 5, p 46) divided them, according to their histologic appearance and clinical course, into groups of low and high degrees of malignancy. They found that at least half of them

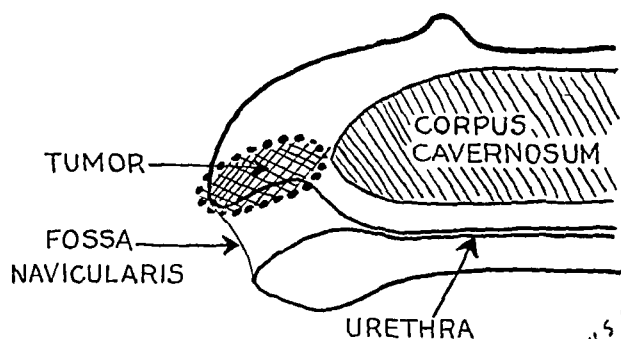


FIG 1

(26) belonged to the former group while the remainder (24) belonged to the latter. Basal cell carcinoma of the penis is so rare that a cursory examination of the literature and a consultation with two capable pathologists has failed to reveal the record of a case of the relatively non-malignant

type of tumor (so located), which is described in the following case.

September 23, 1925, a sixty-seven-year-old man came to me complaining of a small lump near the end of his penis. He was of the lean type, apparently in good health and had no other complaints. There was no loss of weight. His past history is irrelevant. He had noticed the lump about nine weeks before I first saw him. Examination of the penis by inspection revealed very little. There was a very slight bulge outward just above the meatus and on separating the lips of the meatus a slight bulging in of the roof of the urethra could be detected. But apart from a slightly granular appearance of the glans and the urethral mucosa over the bulging part, the glans and urethra appeared to be normal. On palpation of the glans, however, one could distinctly outline more or less definitely an elongated mass which apparently was shaped like a jelly bean. It was about  $1\frac{1}{2}$  centimetres long and a little over  $\frac{1}{2}$  centimetre in its transverse diameter. It did not feel hard but was firm enough to permit of definite palpation and seemed to lie on top of the urethra and run more or less parallel to it (Fig 1).

Under local anesthesia a small piece of the lesion, including a little bit of the meatus, was removed for microscopic examination. The specimen was examined in the Cornell Medical College laboratory by Doctors Ewing and Smith who reported it to be a basal cell carcinoma, clinically non-malignant (Figs 2 and 3).

Since this is the type of neoplastic growth that usually responds well to radium, radium therapy was decided upon. October 18, 1929, a gold seed containing 1 millicuries of radium emanation was implanted into the growth. I attempted to place this seed as near the centre of the mass as possible. About two weeks later the patient was seen

\*Read at a meeting of the American Association of Genito-Urinary Surgeons, June 4, 1931

## STRANGULATED FEMORAL HERNIA OF FALLOPIAN TUBE

It is very rare that the Fallopian tube escapes through the femoral canal into the sac. The tubes as a rule are on a lower level than the femoral opening. The following case therefore is worthy of record.

**CASE REPORT**—Mrs. A. H., fifty, married, four children, normal deliveries. Previous history negative except for metrorrhagia for past few years. Patient was diagnosed to have a bleeding fibroid uterus. Four days prior to admission to hospital for removal, the patient noticed for the first time a mass in the right femoral region about the size of a small tangerine which gradually increased in size to that of a large orange. She complained of pain and tenderness in the region of the mass. She was admitted to the United Israel-Zion Hospital on March 30, 1931. When admitted there was a mass about the size of a large fist in the right inguinal region, quite tense, tender, skin freely movable over it, fixed to underlying structures, no impulse on coughing, irreducible and flat on percussion. Vaginal examination revealed the uterus to be about three times its normal size, somewhat tender, pulled over and fixed to the right. From the general appearance of the mass one would make the diagnosis of a strangulated femoral hernia, which most often contains small intestine.

Under spinal anesthesia the sac was exposed. It was about the size of a large fist, of dark plum color, it was dissected down to its neck which was found to be right underneath Poupart's ligament and firmly constricted at the site of the femoral ring. As the sac was incised there was an escape of about half a glass of bloody fluid. In the sac was found a swollen oedematous tubular mass about the size of a frankfurter sausage. Its distal end was rounded and club shaped, and its proximal end was constricted at the neck of the sac. At first sight it appeared like a small intestine but it only had one limb of a loop, on close examination it proved to be a strangulated oedematous right Fallopian tube.

The mass could not be reduced with the same ease as strangulated small intestine as it was practically a solid tumor mass with its diameter much larger than the opening of the femoral canal. A salpingectomy was accordingly done. This was readily accomplished by pulling on the tube and its mesosalpinx until the cornu of the uterus could be felt with the finger. When the tube, which corked the femoral canal, was removed, a large amount of bloody fluid escaped from the peritoneal cavity, apparently due to some impaired circulation of the broad ligament and right ovary. The sac was quite thick and oedematous. On its outer surface was a thick layer of pendulous, polypoid, preperitoneal fat. It was dealt with as an ordinary femoral hernia, ligating the sac at its neck, high up, and removing it. The under surface of Poupart's ligament was then sutured to the pectineus muscle and fascia with interrupted chromic No. 2, thus obliterating the femoral canal.

A hysterectomy was then proceeded with. This was done through the original skin and fascial hernial incision. These tissues were retracted toward the mid-line and the right rectus sheath with the peritoneum were then incised. More bloody fluid escaped. The abdominal cavity was explored. The uterus was found to have a good-sized fibroid in its body and small fibroids in its cervical portion. One could then also see the ligated stump of the right tube and the ligated neck of the sac pulled upwards away from the femoral canal. With no difficulty a complete hysterectomy was done including both ovaries, left tube, and cervix. The entire procedure, the salpingectomy, hernioplasty, and hysterectomy, with complete closure, lasted thirty minutes.

The patient had a very satisfactory convalescence. The wound healed by primary union. Looking at the scar, which is typical for a hernioplasty, one has to stretch his imagination to believe that a hysterectomy was performed through such an incision.

## BRIEF COMMUNICATIONS

- 2 Introduction of grooved-director alongside of the needle Withdrawal of the needle
- 3 Introduction of blunt dressing forceps alongside of grooved-director to spread open the tract
- 4 Enlargement of tract to the desired width by means of a knife

The following features of this procedure are objectionable

- 1 In introducing the grooved-director alongside of the aspirating needle after the cavity has been located, the surgeon often misses the cavity because he introduces the instrument for either too great or too short a distance
- 2 The conventional blunt grooved-director produces considerable trauma by tearing through indurated tissue when introduced This is particularly true when dealing with inflamed pulmonary tissue
- 3 The blunt dressing forceps produces similar trauma when introduced, and especially when the blades are spread to tear open the tract more widely
- 4 The procedure, if carefully done, consumes considerable time

In order to obviate the above-mentioned difficulties, a simple set of instruments which has simplified and rendered the procedure more precise, was devised The set consists of

- 1 Aspirating needles which are calibrated in centimetres
- 2 A grooved-director similarly calibrated and bearing a sharp-cutting point
- 3 A special pair of scissors which resembles an ordinary sharp-pointed, long-bladed pair, with the exception that the back of each blade is ground down to a fine cutting edge One blade and shank are calibrated in centimetres

In opening a deep-seated abscess with this set of instruments, the procedure consists of locating the cavity in the usual manner with the aspirating needle, at the same time noting the depth at which pus is encountered This depth is readily visible on the calibrated needle The calibrated sharp-pointed cutting grooved-director is then readily introduced alongside of the needle, for exactly the same distance, thus making sure that the tip of the grooved-director lies in the abscess cavity The aspirating needle is then removed Next, the special pair of scissors is introduced alongside of the grooved-director for the desired distance as noted on the calibrations, and the blades are opened The scissors are then withdrawn, holding the blades firmly in the opened position This manoeuvre enables the surgeon to open the cavity as widely as is desired, as the cutting edge on the back of each blade acts as a knife By opening the blades to the desired position, a drainage tract of any given diameter can be readily produced

ARTHUR S W TOUROFF, M D,  
*New York, N Y*



## BOOK REVIEW

COLLECTED PAPERS, 1904 to 1929 by EDWIN BEER, M D 8 vo , cloth, 838 pp Paul B Hoeber, New York, 1931

Here is a book of over 800 pages, containing ninety different papers, upon various subjects, which record some of the work of a single New York surgeon during twenty-five years. It is evident that the author has been in the midst of an active and progressive surgical period, the experiences of which and the results accomplished during which have been the subject of constant study.

We have therefore in this book a reflection of the intense activity and the progressive nature of the surgical world during the first quarter of the twentieth century—a period built upon antiseptics, varied processes of anæsthesia, and constantly developing knowledge of physiology.

The book therefore may well serve as an introduction to the accomplishments of the surgery of the twentieth century. As one reflects upon its character one cannot help being struck by the importance of the foundations established by the work of such men as Morton and Simpson in general anæsthesia, Lister and the surgeons of the '80s in antiseptics, and Koller and Labat and their associates in local anæsthesia, and the many enthusiastic laborers in physiologic and pathologic laboratories from Vuchow and Claude Bernard during the last half of the century, upon which the accomplishments of the surgeons of the twentieth century are based. Doctor Beer's work belongs to the twentieth century. His papers are grouped under various heads, such as gastro-intestinal subjects, the liver, the genito-urinary system (which includes by far the greater number of papers), with papers on the spleen and on the spinal cord, and a few miscellaneous papers.

While many of these are brief, there are some of comprehensive character and of lasting value. We note particularly the three papers, making forty pages, devoted to the urinary organs of children, several papers on bladder tumors, aggregating sixty pages in all. A paper on total cystectomy for cancer should not be overlooked, and also one on functional renal tests. The therapeutic value of artificial hyperæmia is the subject of extended treatment.

The volume as a whole presents a valuable picture of the possible activities in the domain of surgery which the present-day offers to an active and enthusiastic worker in its fields. The example of Doctor Beer in thus collecting and presenting his work is to be commended to the imitation of his colleagues.

LEWIS S PILCHER

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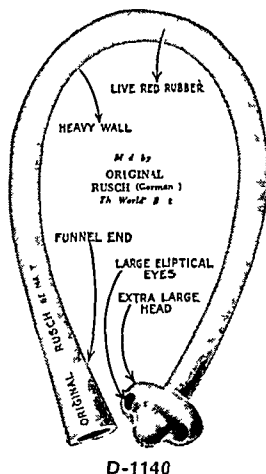
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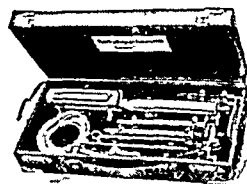
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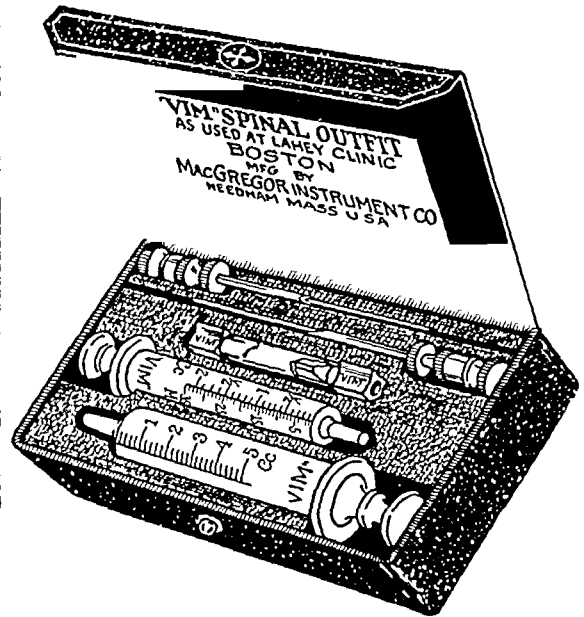
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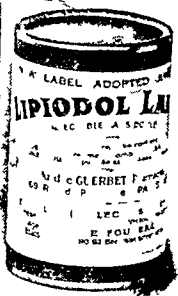
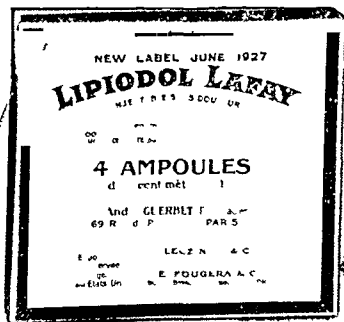
2 Labat *Nelson Loose Leaf Living Surgery* Survey of Literature from July 1 1928 to June 1 1929 (issued October 1929) p. 65-67

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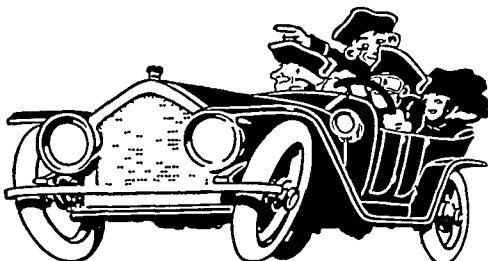
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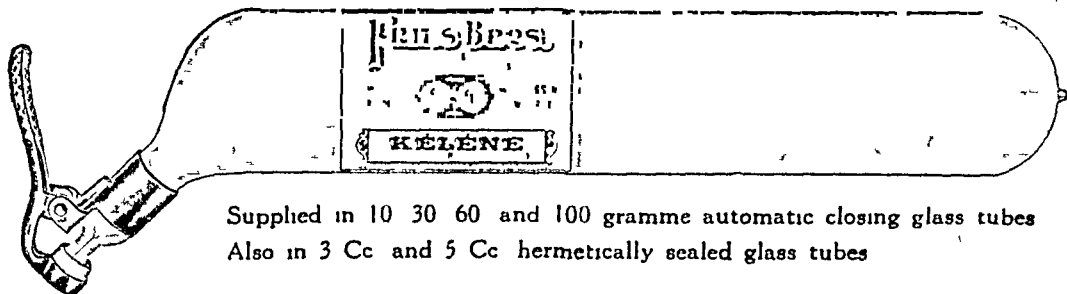
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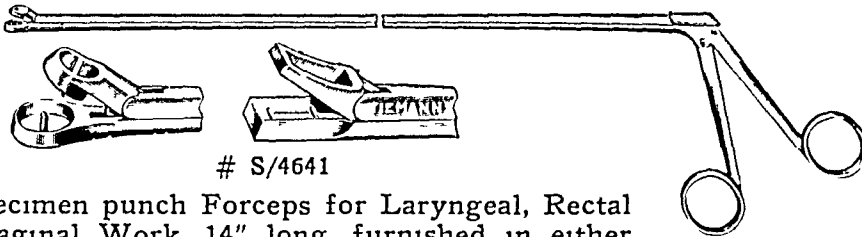


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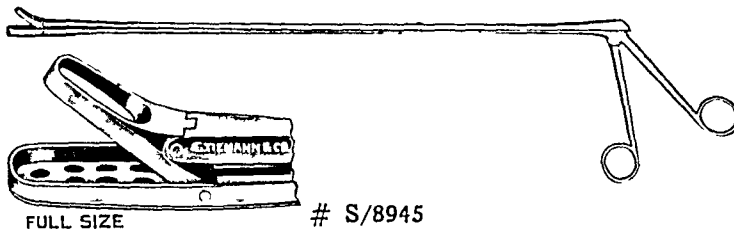
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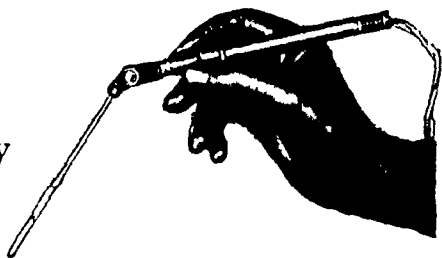
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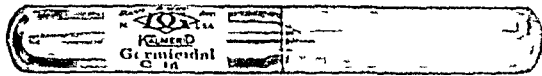
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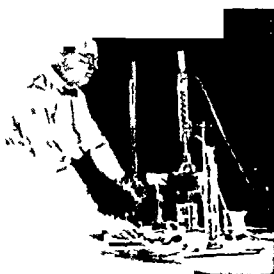
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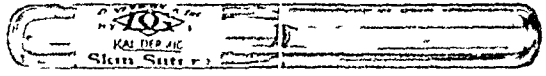


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in stimulating progress and in maintaining the highest ethical standards of our profession, I can conceive of no greater honor in surgery than to be elected its president. For thirty years the Association has extended the privilege of fellowship to Canadians, a privilege that has been highly valued. In fact today in Canada, as in the United States, membership in this Association is regarded as the "blue ribbon" for achievement in the surgical field. I thank my colleagues most sincerely for the confidence they have accorded me in placing me in the president's chair. I am conscious of the fact that my personal contribution to the activities of the society fail to merit this honor, but apart from this consideration I regard my election as a graceful mark of courtesy to my fellow Canadians among whom I am at present one of the senior living members.

The senior fellows of this Association form a privileged class. Our relationship to the Association as a whole might be described as *in loco parentis* carrying all the responsibilities of our station. Our function, I take it is to encourage and stimulate a progressive spirit among our active members during that period of their professional career when opportunity, and the ability to grasp it, enables them to make important contributions to the advancement of the science and art of surgery. There may be a large element of truth in the sentiment of Burke that "the arrogance of age must submit to be taught by youth" but we may perform a useful function by utilizing our experiences in helping to assess the value of new discovery. "Experience, that excellent master," says Pliny, "has taught me many things." It is with some such consideration in mind I venture to refer to certain experiences in my own surgical activities.

Since the days of Hippocrates clinical records have been preserved and have been studied with great interest and profit. The gradual evolution of medical science may be largely read in records coming down to us from antiquity "records that defy the tooth of time." Many observations were recorded in illustration of knowledge laboriously accumulated regarding the healing of wounds and the return to normal of diseased and damaged tissues. A natural tendency for wounds to heal and for diseased organs to recover were among the facts early recognized. The *vis medicatrix naturæ* was a factor paramount in the remedial process. Ambroise Pare, the famous French war surgeon of the sixteenth century, quaintly expressed it by concluding his description of a successful case with the words, "I dressed him, God healed him." Again there is an ancient saying to the same effect "Wounds have an insuperable tendency to heal."

One occasionally is impressed with the results that may be traced over a long period of years. The end results in surgery may be studied with great profit and for that purpose there is in operation in every well-equipped modern hospital a "follow-up system." It is a difficult undertaking and demands much labor and painstaking investigation. But such methods are

us that there were records of men who had been employed in such works for perhaps two years and had quit to take up other employment. Such men, ten or twenty years afterwards, presented themselves with the characteristic cancer of the bladder found in those working in aniline dyes. Archibald Leitch, of the Cancer Hospital, London at the International Conference on Cancer in London (1928), stated that in cotton spinners, where cancer is produced by mineral oils, it has taken as much as sixty years to produce the result. He, however, attributed such results to the length of time of exposure to the noxious agent. These facts would suggest that what we are pleased to call "early cancer" may have been in existence for long periods, years possibly, before it has developed sufficiently to be recognized as a clinical entity. It has been suggested that the initial stages in cancer development may occur many years before a growth can be recognized. This hypothesis has been advanced to account for the fact that cancer rarely appears in early life and when it does appear early we always find the more rapidly growing type, it is very cellular, and is described as encephaloid with a minimum amount of fibrous stroma.

In 1920 I read a paper before this Association in which I described primary carcinoma of the appendix in two sisters both of whom were tuberculous. One had suffered from pulmonary tuberculosis and the other had a tuberculous Fallopian tube to which the appendix with its tumor, was adherent. In my paper I called attention to the fact that, in cases reported in the literature, tuberculosis and cancer of the appendix of the basal-celled type are frequently associated. I also cited a case reported by Barbour and Watson of a Fallopian tube that had been removed, showing histologically a typical picture of tubercle at one end of the tube and an equally typical picture of carcinoma at the other. I suggested that there might be some significance in this relationship between tuberculosis and cancer that had not been previously recognized.

Some twenty-five years ago Dr. Sampson Handley showed that cancer spread mainly by lymphatic permeation. He has recently published a paper in which he concludes from experimental and clinical evidence that lymph stasis plays an important rôle in the etiology of cancer. His statement is as follows: "My observations lead me to believe that the origin of cancer is intimately associated with local obstruction of the lymph-vessels in the area where the cancer arises." "To produce cancer," he adds, "the obstruction must be of long standing—must have lasted for twenty to thirty years." Sampson Handley observes that tuberculous processes tend to the production of lymph stasis and the sequence of events may be studied in certain forms of tubercle. Thus he cites, as an example, lupus erythematosus in which as a result of lymph stasis we may have papillary hypertrophy, definite papillomata and ultimately cancer. He quotes some interesting observations made by Dr. Thomas Cherry, of Melbourne, who ascertained statistically that, whereas during the last thirty years the death rate from tuberculosis has greatly diminished and that from cancer has greatly increased, the com-

The contour of the bullet appears unaltered and its edges are sharply defined (Fig 1) Unlike the ivory peg described in my first case, this foreign body, composed of lead, remains unaltered in size and shape after forty-five years The presence of such a non-absorbible body causes a tissue reaction that results in the formation of a



FIG 1—X ray picture of a bullet embedded in the deep muscles of the neck for forty five years (Case II)

fibrous capsule The length of time that must elapse before the final stages of encapsulation are reached, have not been ascertained

CASE III—*After eleven and a half years*—Under favorable conditions a graft of dead bone introduced into the tissues becomes absorbed and disappears This fact is illustrated in the case of a man thirty years of age who had a large hiatus in the parietal

iliac crests. No abscess can be felt. Movements of the spine are remarkably free. The range cannot be distinguished from normal. Movement takes place in the lower lumbar segment, and the dorsal region. The central lumbar segment is rigid. He has no pain, and is able to perform heavy manual labor without difficulty.

The X-rays show the remnants of the bodies of four lumbar vertebrae, the second, third, fourth and fifth, are fused together in a solid bony mass (Fig 2). There is no trace of intervertebral discs between these bodies nor is there any indication of the individual bodies. The bony mass which represents the fused bodies is small, scarcely larger than a normal lumbar vertebra. The divisions are identified by the pedicles, the

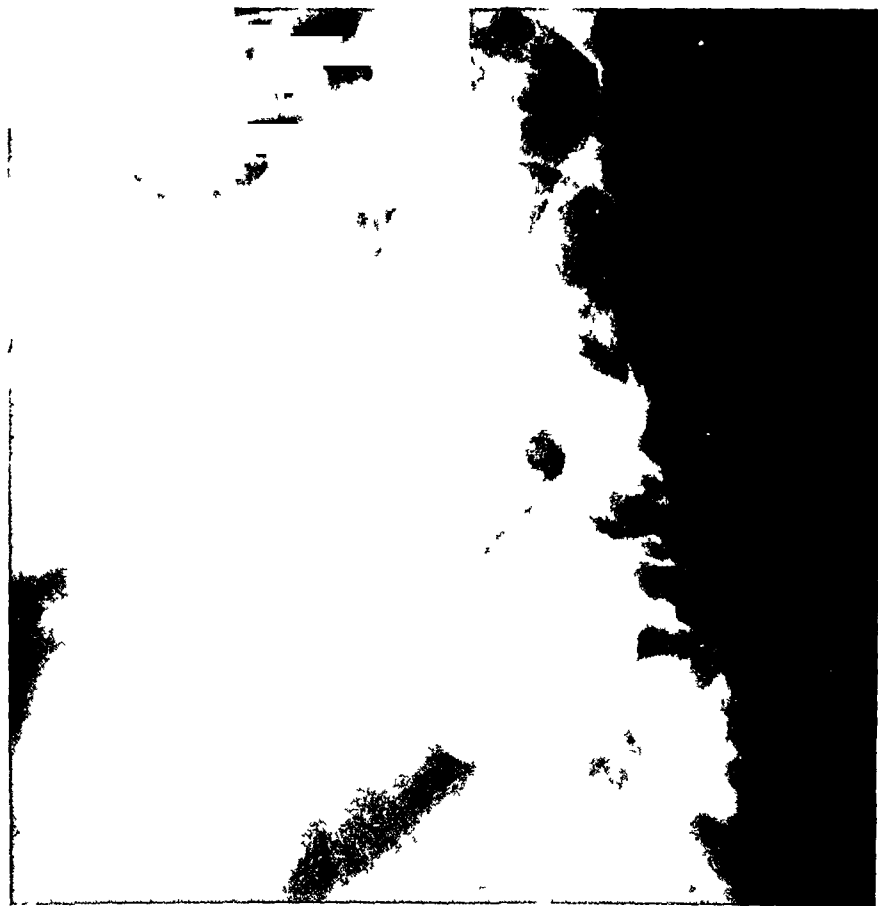


FIG 2—Roentgen ray of the lumbar spine showing complete fusion of four vertebral bodies in a solid bony column forty years after operating for double psoas abscess contingent upon a tuberculous spine (Case IV)

spinous processes and the intervertebral foramina. The foramina are normal in size and shape. The twelfth dorsal and the first lumbar vertebral bodies are normal.

It is impossible to estimate with accuracy the length of time that necessarily elapsed before the conditions found today, forty years after the primary treatment, were finally reached. We may safely assume that many years passed before complete fusion of the vertebral bodies and the reproduction of normal bone tissue occurred.

I have endeavored to demonstrate the fact that tissue change both in new growths and in the process of repair may continue over many years. This circumstance must have an important bearing on our diagnosis, prognosis and treatment.

therefore, those procedures which do not create serious technical difficulties, should recurrence take place, have very definite advantages. In this respect excision of the primary lesion with reconstruction of the pyloric outlet is an excellent procedure and can be satisfactorily done much more often than is supposed. In some cases, partial gastrectomy is the operation of choice, and it is to the method of performing this that I wish to draw attention.

The first case in which I carried out the procedure to be described was that of a man aged thirty-nine years on whom I had already done two resections of the stomach for recurrent ulcer. The first resection had been an extensive one of the Polya type for jejunal ulcer but this was soon followed by symptoms of recurrence, for which resection was plainly necessitated. This was accomplished by a modified Hoffmeister-Roux procedure, but relief of symptoms was of short duration. Symptoms were more severe than at any previous time and disability was complete. The acidity of the gastric content was reduced to a point at which free hydrochloric acid was frequently absent. At operation an enormous ulcer involving the jejunum and adjacent portion of the stomach was found, the crater of which was about 3.5 centimetres in diameter. The infiltration of surrounding tissues and of the colon was most extensive. It seemed reasonable to doubt that control of the disease could be secured by repeating a procedure which had already failed twice, and it seemed desirable to unite, if possible, the fundus of the stomach and the duodenum. The portion of the jejunum which contained the ulcer and an adjacent segment of stomach were first resected *en bloc*, end-to-end anastomosis of the two resulting portions of the jejunum was done, and about half of the end of the stomach was closed. The duodenal stump had already been explored and I found it possible to mobilize it sufficiently so that anastomosis could be made between the open end of the stomach and the lateral wall of the duodenum. A catheter was introduced into the upper part of the jejunum, and was used for administration of fluids and nourishment for ten days. The patient recovered uneventfully and returned home in three weeks.

I have carried out this same procedure in two other cases, one a case of jejunal ulcer following partial gastrectomy, and the second a case of jejunal ulcer in which, at the first operation elsewhere, the duodenum had been completely divided, so that with a small gastroenteric stoma, partially blocked, almost complete obstruction was present. In the three cases most satisfactory results followed, and it is reasonable to believe that the prospects of preventing recurrence are better than those following any previous procedure. The union of a resected stomach and the duodenum should carry with it all the advantages of full utilization of the alkaline juices of the duodenum, and thereby should reduce the liability of recurrent ulcer to a minimum.

DISCUSSION.—DR J. SHELTON HORSLEY (Richmond, Virginia) said that he had had several cases of recurrences of this type and he had been using the technic which he showed in connection with operations for cancer of the stomach before this Association several years ago, where the stump of the stomach is brought to the duodenum along the lesser curvature, preserving the physical functions of the peristalsis, the end of the duodenum is split, flaring it open, in some instances flared open to make an end-to-end, and in other instances the lower portions of the curvature are tucked in.

In spite of this, however, he had had recurrences in two cases. One of them was a patient who had been operated on five times before Doctor Horsley saw him. He had a

ulcers. The only criticism that he thought could be made of the finality of the decision of the Association on that occasion is that the plastic operation that is done so much now in southern Europe didn't have quite a fair hearing. It was not presented by anybody, and there was no comparison between the two.

This work of Doctor Balfour's savors of the two—it savors of the Linnich idea of opening up the pylorus in the duodenum, and of resection of a large amount of the stomach, which is the thing advocated by the men in southern Europe, with the idea of lessening the amount of hydrochloric acid secreted by the stomach by thoroughly cutting the pylorus away from the rest of the stomach. The thing is still just a little *sub rosa* in regard to the relative position of this operation that is done in Europe as compared to gastroenterostomy.

DOCTOR BALFOUR rejoined that he had intended to restrict the discussion to those cases in which it has been made obvious that the jejunum will not stand, or hook up with the stomach, in other words, those few patients who, for some reason or other, develop jejunal ulcers after an anastomosis between the stomach and the jejunum. That is the puzzle. Why is it that only a few out of a hundred will develop a jejunal ulcer? A restoration of the stomach to the duodenum is something to be kept in mind.

He thought it proper now to say that he was not discussing here at all the question of primary, partial gastrectomies or lesions, particularly lesions of the duodenum. Those who have followed very closely the work of the continental surgeons who are advocating radical operations for duodenal ulcers are convinced of one or two points.

(1) As Walter has recently showed—he has just been over there and spent six weeks in very carefully studying the work going on in those clinics and he is convinced of the truth of what they said—they are dealing with entirely different lesions, that is, they are large perforating lesions associated with marked gastritis. They talk a great deal of gastritis associated with these lesions. Whether that is due to the delay in treating these patients a delay in surgery, or whether it is due to the type of life which is led there (frequent and hearty eating of perhaps undigestible foods), it is hard to tell. Anyway, he was convinced that those lesions were of an entirely different type, and might lead surgeons into more radical procedures.

(2) The most interesting thing he got out of the report he made was that about 80 per cent in the clinics that have made careful investigations, have perfect results from resections, and 20 per cent of the patients who follow along with dyspepsia are put down to gastritis.

Of course, this can be continued almost indefinitely, this discussion of a partial gastrectomy of the duodenum. At one clinic, they are all doing one thing, at another clinic, the man says that that is no good, and he advocates something else. So it is rather confusing. But he thought through it all one finds that things are not entirely all right with those who advocate a more radical procedure, and it leaves one the feeling that it is best to do a conservative operation because it at least carries a low mortality rate.

that of calcium carbonate is fifteen times as great. A review of literature on X-ray diagnosis of gall-stones, such as Carmen,<sup>10</sup> George and Leonard,<sup>11</sup> Schinz, Baensch, and Friedl,<sup>12</sup> and Eisler and Kopstein,<sup>13</sup> reveals numerous cases that present the roentgenologic aspects of calcium-carbonate stones or paste but as a rule the correlation of roentgenologic, pathologic and chemical findings is not sufficiently adequate for the establishment of an accurate diagnosis. In discussing the pathology of the gall-bladder in cases of cystic-duct obstruction Kaufmann<sup>14</sup> states that in some cases the gall-bladder may be found contracted and filled with a chalky gravel (Kalkgries).

In our studies of seven cases diagnosed as calcium-carbonate deposits in the lumen of the gall-bladder, the observation has been made that the cystic duct or neck of the gall-bladder was obstructed by a gall-stone of the ordinary cholesterol or cholesterol-pigment variety in every instance. Dr. Allen Whipple, of New York, has kindly furnished us with a report of calcium-carbonate paste in a gall-bladder the cystic duct of which was obstructed by a carcinoma which was primary in the gall-bladder. These findings indicate that the duct obstruction was a precursor and a determining factor in the calcium-carbonate stone or paste formation. In the cases in which the duct was obstructed by a calculus, the order of development of changes appeared to be as follows. First, there was cholecystitis and the formation of gall-stones of either cholesterol or cholesterol-calcium-bile-pigment variety. One of the stones produced obstruction either in the cystic duct or in the ampulla of the gall-bladder. Following this a pathologic condition was set up whereby calcium carbonate was excreted by the wall of the gall-bladder, in one case forming a separate stone, in five cases encasing preexisting cholesterol-pigment stones, and in one case forming a combination of a white paste and a white stone encasing preexisting cholesterol-bile-pigment stones. The ordinary stones appear to act as a trigger for the precipitation of the calcium carbonate. In four cases the calcium carbonate produced the X-ray appearance of concentrated radio-opaque dye (iodoikon) in a gall-bladder containing either no stones or radio-translucent stones. In three cases there was deposition of calcium carbonate on the gall-bladder side of the obstructing stone, producing a shadow in roentgenograms which made it possible to diagnose the presence of calculous obstruction of the duct as well as calcium-carbonate deposition in the cavity of the gall-bladder. The condition has been met with four times among 313 cases of gall-stones in the University of Chicago clinics during the three years and eight months that they have been open, showing that the lesion is not extremely rare. Two cases are from the Presbyterian Hospital and one from the Peking Union Hospital. A preliminary report of these cases has been made (J. A. M. A.)

*CASE I—Cholesterol stone in cystic duct with slow growth of calcium-carbonate stone in gall-bladder and calcium-carbonate deposit on stone in cystic duct revealed by a series of roentgenograms.* Woman, age forty-four, had had repeated attacks of pain in the epigastrium and, curiously, the left upper quadrant extending to the left scapular region for the past fifteen years. Following an attack a cholecystography was per-





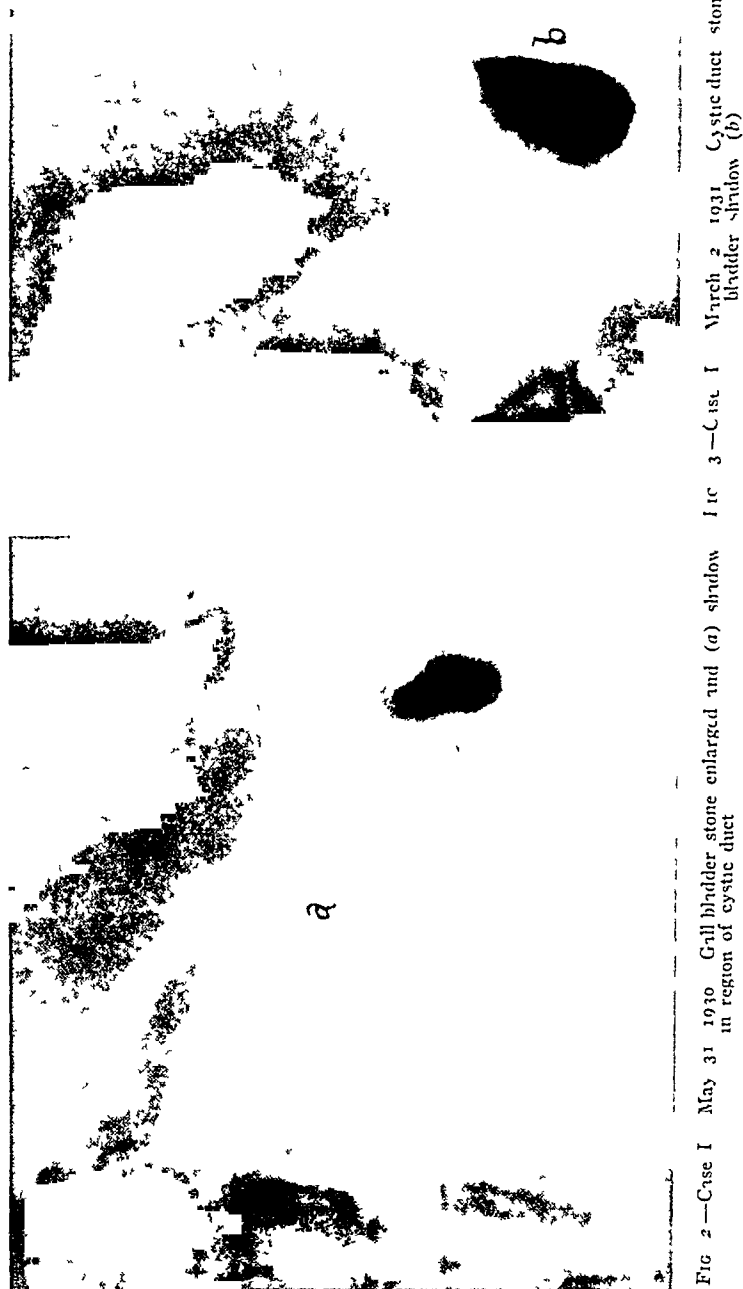


FIG. 2—Case I May 31 1930 Gall bladder stone enlarged and (a) shadow in region of cystic duct  
 March 2 1931 Cystic duct stone (a) Gall bladder shadow (b)

Microscopic sections of the wall revealed moderate fibrous thickening with scattered areas of round-cell infiltration. The mucosa was intact in most of its extent but had disappeared over many of the villi which showed an increase in the number of fibroblasts and round-cell infiltration. Some of the villi showed glands markedly distended with mucus (Fig 7).

Chemical analysis of the white stone gave calcium carbonate 85 per cent, and calcium phosphate 2.5 per cent. The rest consisted of organic matter. There was no bile pigment or cholesterol.

CASE II—*Calcium-carbonate stones incorporating other stones and producing the X-ray picture resembling concentrated radio-opaque dye in the gall-bladder.* Female, age fifty-five, had had attacks of gall-stone colic at irregular intervals for several years. There had never been jaundice but some of the attacks had apparently been accompanied

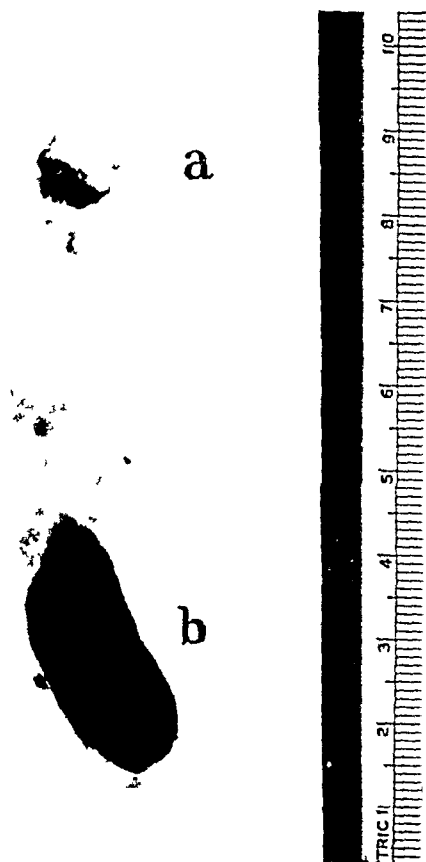


Fig 5



Fig 6

FIG 5—Case I Rontgenogram of specimen showing (a) cystic duct stone (b) gall bladder stone and numerous calcium flakes

FIG 6—Case I Gall bladder opened showing (a) cystic duct stone, (b) Gall bladder stone and mucus in gall bladder

by fever. Physical examination was of no special interest aside from tenderness in the right upper quadrant. A rontgenogram (Fig 8), taken nine months before admission, revealed an opaque shadow of the size and shape of the gall-bladder and containing two translucent areas suggesting radio-translucent stones. A new radiogram (Fig 9) showed the opaque shadow and the radio-translucent areas within it more sharply circumscribed than before. Rontgenograms taken after administration of iodoikon showed no change in the shadow.

Dr E M Miller, at the Presbyterian Hospital The gall-bladder contained a large stone and there was a stone in the cystic duct which was milked out with great difficulty Cholecystectomy The gall-bladder was contracted and its wall thickened On section it was found to contain a few cubic centimetres of a bile-stained mucous fluid and a large clay-colored oval stone measuring 6.5 by 2.5 centimetres The stone was soft and sticky and there was a greenish bile stain on its surface Section of the stone also showed that its interior was slightly bile stained At one end a dark brown concretion presented on its surface (Plate I-b) In a rontgenogram this area is radio

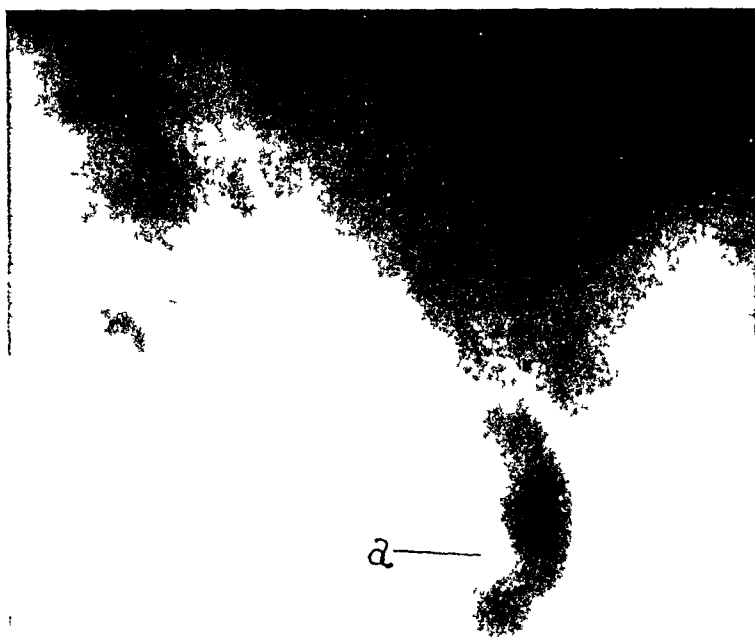


FIG 8—Case II Rontgenogram May 6, 1926 showing (a) radio translucent shadows in opaque gall bladder shadow

translucent while the rest of the stone is radio opaque (Fig 11) The lining of the gall-bladder was hyperæmic and covered with mucus Microscopic section of the gall-bladder revealed loss of the greater portion of the mucous membrane leaving connective tissue bordering on the lumen (Fig 12) There was slight round-cell infiltration and fibrosis of the muscular and serous layers The stone weighed 18.258 grams Chemical analysis of the gray stone showed it to contain 80 per cent of calcium carbonate and 0.46 per cent of calcium phosphate The rest of it consisted of organic matter Bilirubin was present and cholesterol was absent

Although there was a stone in the cystic duct it evidently had not produced complete obstruction continuously since some bile was found in the gall-bladder and the interior of the stone was bile stained As this was the largest stone that was found it would appear that almost pure calcium carbonate may be thrown out in the gall-bladder

coating on its surface (Plate I-c) Cultures of the gall-bladder wall yielded an anhaemolytic streptococcus Microscopic sections of the gall-bladder showed the mucosa to be intact but there was mucous accumulation in some of the villi with loss of epithelial covering in places There was fibrosis of the entire gall-bladder wall with some infiltration of polymorphonuclear leucocytes and lymphocytes A roentgenogram of the stones

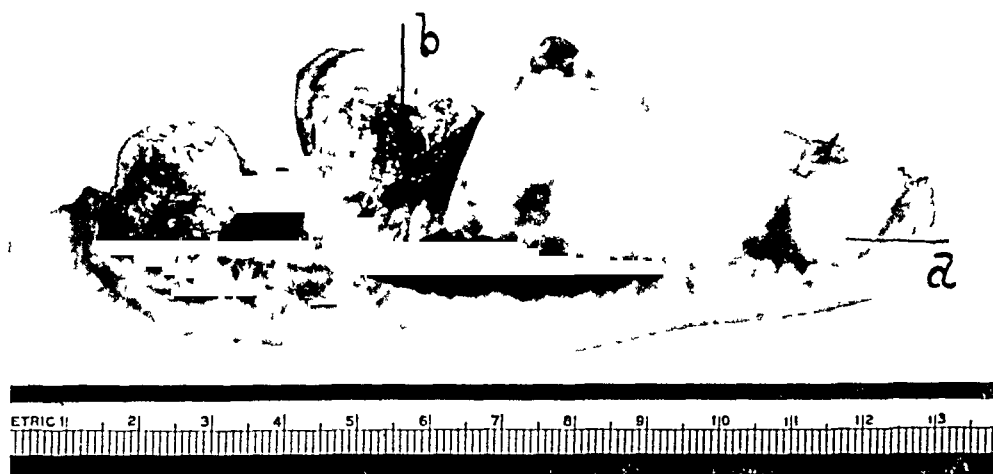


FIG 10—Case II Gall bladder opened (a) Stone in cystic duct (b) Cholesterol pigment stone showing on broken surface of the calcium carbonate stone

in the gall-bladder (Fig 14) brings out well the calcium-carbonate coating of the proximal bile-pigment-cholesterol stone and the small, radio-translucent calculous inclusions in the distal stone Chemical analysis of the grayish-white material comprising the distal stone revealed calcium carbonate 74 per cent, calcium phosphate 3.1 per cent, cholesterol and bile pigment present in small amount The rest of the stone consisted

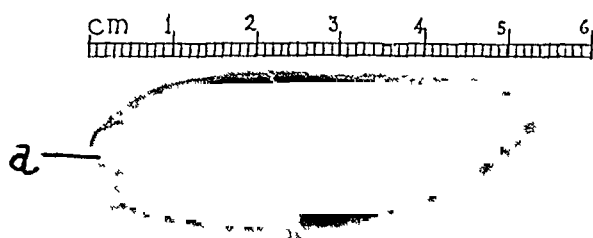


FIG 11—Case III Roentgenogram of stone showing (a) cholesterol pigment stone incorporated

of organic matter The presence of a small amount of bile in the fluid and of bile pigment in the calcium-carbonate stone showed that some bile was entering the gall-bladder at least at times despite the stone in the cystic duct However, the amount of fluid passing by the stone must have been enormously reduced as shown by its considerable size and by the

failure of concentration of iodoikon in the gall-bladder

CASE V—Shows a combination of chalky fluid in the gall-bladder and duct with a pasty opaque stone incorporating several bile-pigment stones Female, age twenty-six, treated in Pekin Union Medical College She gave a history of attack of right upper quadrant pain radiating to right shoulder occurring at intervals over a period of two years They often started with nausea and vomiting and were usually of short duration There was no history of jaundice or fever Physical examination was essentially negative aside from tenderness in the gall-bladder region A roentgenogram (Fig 15) revealed an opaque shadow roughly outlining the lower part of the gall-bladder There was no

or tenderness in the gall-bladder region. A roentgenogram of the gall-bladder region (Fig. 17) revealed a finger-shaped opaque shadow in the region of the gall-bladder which was rounded at its lower end and irregular at its upper end. Above this and near the tip of the right transverse process of the first lumbar vertebra was an irregular ring-shaped opaque shadow in the region of the cystic duct. Roentgenograms taken after intravenous iodoikon administration at intervals for thirty-six hours showed changes in the contour of the gall-bladder shadow but no increase in its size or density and no change in the shadow in the region of the cystic duct. The diagnosis was made of a gall-stone obstructing the cystic duct with deposition of calcium carbonate on its surface.



FIG. 13.—Case III. Shadows in region of gall bladder incorporating radio translucent areas and (a) shadow in region of cystic duct.

and a calcium-carbonate deposit in the gall-bladder that was soft in consistency and changeable in form. The patient refused operation.

CASE VII—Female, age thirty-one, entered the University of Chicago clinics, May 15, 1930. Past and family histories were irrelevant. Five months previously she had an attack of upper abdominal pain which radiated to the right shoulder lasting for about two hours. Since then there have been three similar attacks, the last one occurring about three weeks ago. She sometimes had distress after meals which was relieved by belching. There had been no jaundice and no fever. Physical examination revealed an obese young woman with essentially negative regional findings aside from tender-

very slight to almost complete loss of mucous lining. There is exudation into the gall-bladder lumen which contains a variable quantity of mucus. In some cases it is extensive and very thick. The fact that in no case was there marked enlargement with hydrops of the gall-bladder suggests that when the intravesical tension passes a certain point the exudate may escape past the obstructing stone into the ducts beyond. The absence of bile and the relatively high degree of obstruction in three of the five cases coming to operation makes it appear that the calcium carbonate was excreted by the wall of the gall-bladder.

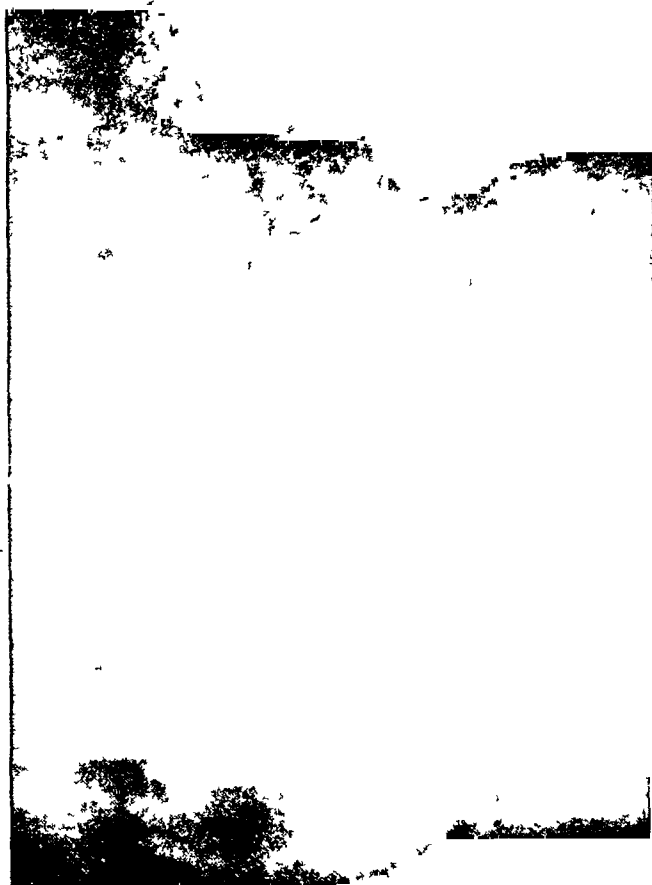


FIG. 15.—Case V. Shadow has configuration of lower part of gall bladder.

and that it was not derived from the bile. The presence in three cases of calcium-carbonate deposit on the cystic duct stone most marked or only on its gall-bladder side is further proof of the fact that it came from the exudate in the gall-bladder rather than from the bile. No adequate explanation can be offered for the selective excretion of calcium carbonate with only traces of calcium phosphate present. It may be as Naunyn<sup>15</sup> claimed, that calcium carbonate is poured out with mucus from the wall of the gall-bladder. Thus

in dogs that ligation of the cystic duct with or without infection caused a lowering of calcium in the bile of the gall-bladder

*Calcification of the Gall-Bladder*—Calcification of the gall-bladder wall with or without associated ossification is an occasional finding particularly at autopsy. It represents an end stage of disease which greatly alters the morphology of the gall-bladder and completely destroys its function. Kaufmann states that it results from a chronic fibrous cholecystitis with diffuse fibrosis and loss of the mucous lining of the gall-bladder. Following this

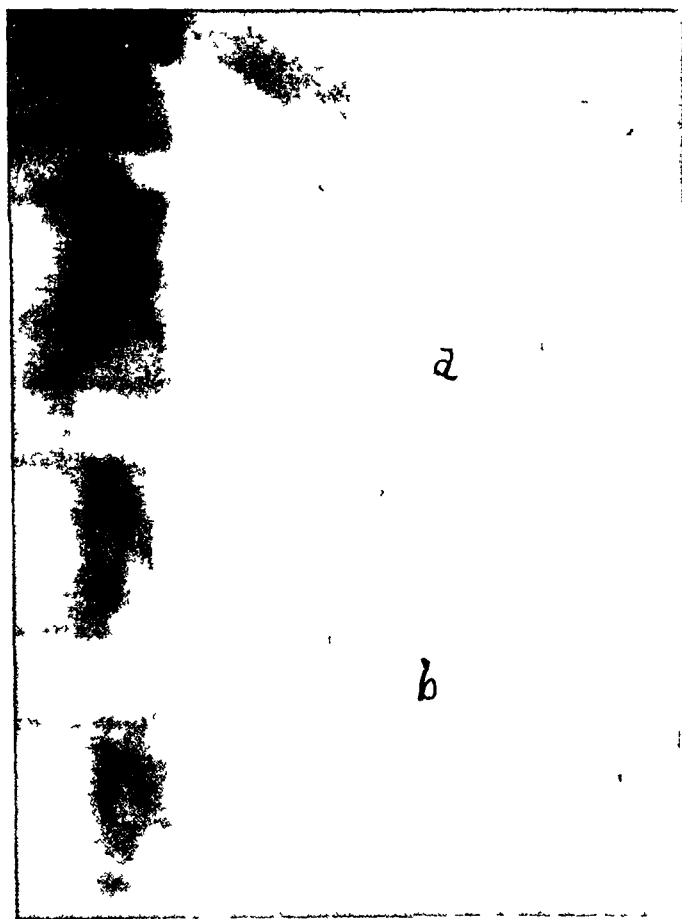


FIG. 17—Case VI Showing shadows in (a) cystic duct and (b) gall bladder

there is deposition of lime salts in the gall-bladder wall. Sometimes the calcified areas may be partly replaced by bone. Osler<sup>22</sup> stated that calcification may be a termination of suppurative cholecystitis. Robb<sup>23</sup> on the other hand, believes that calcification may develop in the absence of infection. He thinks that the constant trauma of stones filling the gall-bladder results in degeneration and fibrous replacement of the tissues of the wall. Fibrosis leads to contracture followed by calcification. In a study of four specimens of calcified gall-bladder derived from autopsies and one operative specimen,



the heavy deposit in the cystic duct. Microscopic section (Fig 22) showed complete fibrosis of the gall-bladder wall with loss of mucous membrane and areas of calcification in the deeper portions of the fibrous tissue.

Figure 23 shows a rontgenogram of a small hard contracted gall-bladder,  $4\frac{1}{2}$  centimetres long removed recently at autopsy from an eighty-two-year old woman dying of carcinoma of the lung. She gave no history of gall-bladder disturbance. On trying to open the gall-bladder a large pure cholesterol stone was found impacted in the neck and first portion of the cystic

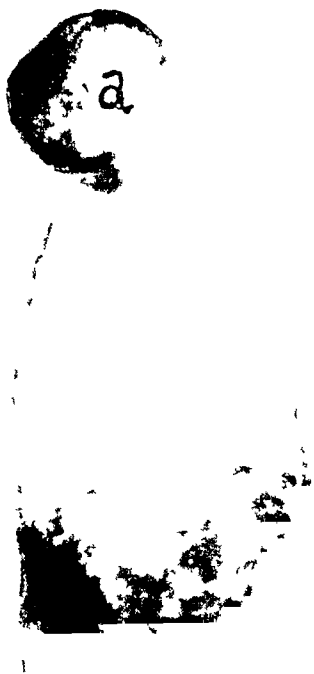


FIG 19—Rontgenogram of gall bladder showing calcification of fundus and of cystic duct (a) at point of impaction of a cholesterol pigment stone



FIG 20—Calcified gall bladder with window excised showing two cholesterol pigment stones within and (a) cystic duct stone with calcareous deposit

duct and fused with the wall by a calcareous deposit. The fundus of the gall-bladder was calcified and its small cavity was filled by a grumous material. Microscopic sections of the fundus showed fibrous tissue replacement of the entire thickness of the wall with a mixture of calcification and ossification in places. The mucosa was completely destroyed.

In another museum specimen the oval gall-bladder was hard and measured 6 centimetres in length. It was completely filled by a stone which was made up very largely of cholesterol and contained two layers of calcium in its deeper portion as shown by shadows cast in rontgenograms. The wall of the gall-bladder was fibrosed and irregularly calcified throughout. The opening of the cystic duct was completely grown over by connective tissue.

Chemical analysis of some of the whitish material removed from the inside of the wall and between the stones showed it to contain 35.5 per cent of inorganic matter of which  $12\frac{1}{2}$  per cent was calcium carbonate and  $87\frac{1}{2}$  per cent calcium phosphate. Hence this process was not analogous to calcium-carbonate calculus formation but was the same as the calcification which is ordinarily seen occurring in necrotic tissues anywhere in the body in which calcium carbonate and calcium phosphate are deposited in about the

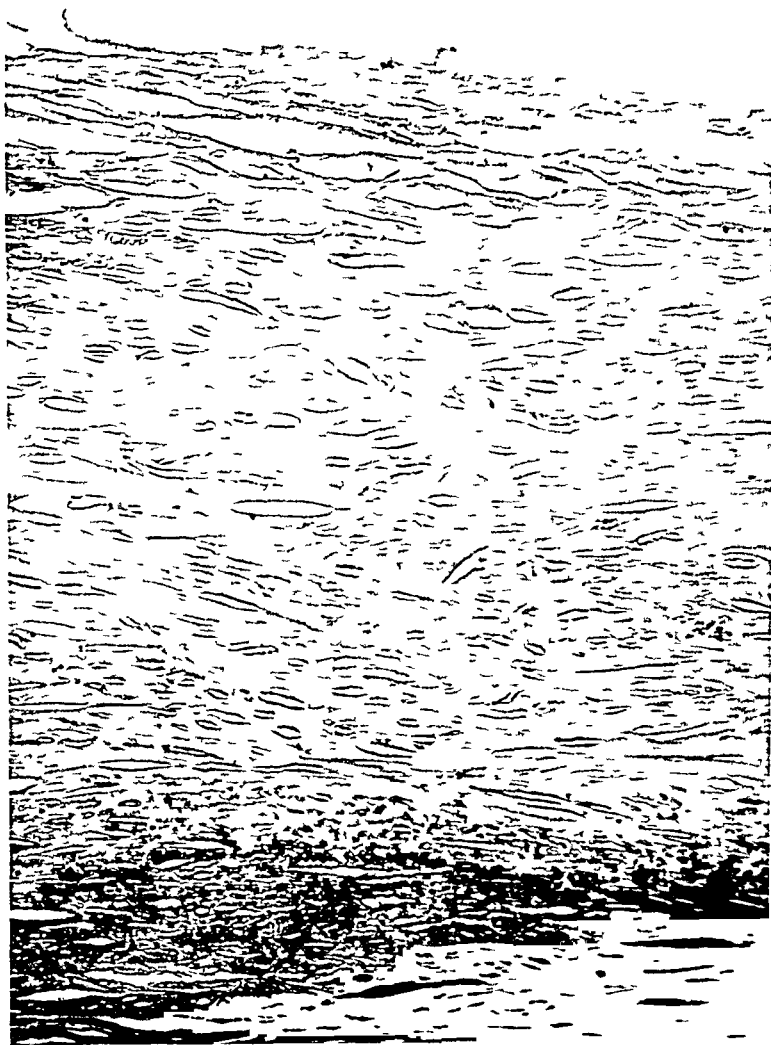


FIG. 22.—Microscopic section of gall bladder in Fig. 19 showing fibrous wall with calcified deeper portion

same relative proportions as in bone. It appears that after cystic-duct obstruction there was degeneration, fibrosis and contracture of the gall-bladder with loss of most of the mucosa. Fibrous tissue grew over the mass of stones and in between them in places and underwent degeneration and calcification where it came in contact with them. In one region there were remnants of mucosa between this encasing layer and the outer muscular coat. It would appear as if the cholesterol-bile-pigment-calcium

duct and particularly on its gall-bladder side making it possible to diagnose both the calcium carbonate deposit in the gall-bladder and the duct obstruction by means of iontgenograms

Obstruction of the cystic duct by one of the ordinary gall-stones may in other cases be followed by degeneration fibrosis and calcification of the wall of the gall-bladder. In such cases there is also calcification of the cystic duct about the stone with fusion of the surfaces of stone and duct. If the gall-bladder is contracted on a mass of stones there may be calcification with cementing of the stones to the wall of the gall-bladder and to a less extent to each other. When the gall-bladder is found calcified in the absence of a stone in the cystic duct, the duct is found obliterated by fibrous tissue at its cystic end.

It should be remembered that while these two pathologic processes are



FIG 24

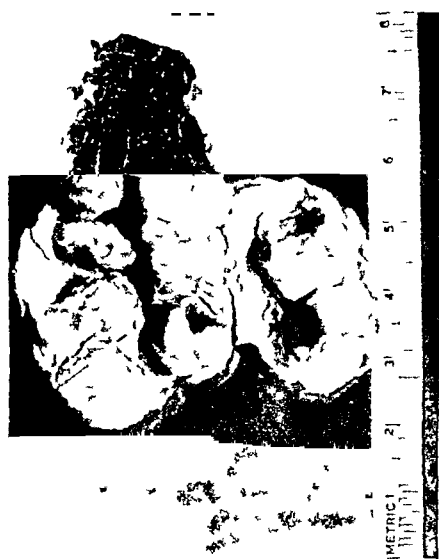


FIG 25

FIG 24—Calcification of gall bladder and cystic duct (a) about stones within.  
FIG 25—Photograph of specimen in Fig 24. Calcified wall opened and showing stones cemented to wall and at (a) to each other by whitish deposit.

closely related they are in reality separate biochemical changes. The calcium-carbonate deposition in the lumen belongs in the realm of stone formation while the calcium-phosphate-calcium-carbonate deposition in the gall-bladder wall belongs in the realm of tissue calcification.

DISCUSSION—DR LEONARD FREEMAN (Denver) said that in an instance where he had the opportunity to observe such a case as mentioned by Doctor Phiemister in his paper, the deposit was entirely a soft, putty-like paste. There were no stones in connection with it at all, not even any grit of any size. There was very little evidence of inflammation of the gall-bladder. There was no obstruction at all of the cystic duct, so the explanation that the calcium deposited in the gall-bladder is due to obstruction of the duct does not seem to apply to all cases. In addition, it would not seem that the inflammation accounted for all instances, as has been suggested by some writers.

This deposit of calcium in the gall-bladder, especially in the way it was found in

- <sup>9</sup> Sasse Über Kalkmilchgalle D Med Woch, vol lvi, p 662, 1930
- <sup>10</sup> Carman The Rontgen Diagnosis of Diseases of the Alimentary Canal Second edition, Philadelphia, 1920
- <sup>11</sup> George, and Leonard Pathologic Gall-bladder Rontgenologically Considered Hoeber, New York, 1922
- <sup>12</sup> Schinz, Bränsch, Friedl Lehrbuch der Rontgendiagnostik Leipzig, 1928
- <sup>13</sup> Eisler, u Kopstein Rontgendiagnostik der Gallenblase Leipzig, 1931
- <sup>14</sup> Kaufmann Lehrbuch der pathologische Anatomie Berlin u Leipzig, 1922
- <sup>15</sup> Naunyn, B Die Gallensteine Jena, 1921
- <sup>16</sup> Besanez, G Lehrb d physiol Chemie, 1874, Quoted in Roberg, Sialolithiasis, ANNALS OF SURGERY, vol xxxv, p 669, 1904
- <sup>17</sup> Rosenthal, M Ein Beitrag zur Kenntnis der lithiasis pancreatica Arch f Verdauungs Krankheiten, vol xx, p 619, 1914
- <sup>18</sup> Wilkie, A L The Bacteriology of Cholecystitis a Clinical and Experimental Study Brit J of Surg, vol xv, p 450, 1928
- <sup>19</sup> Rous, P, McMaster, P D, and Drury, D R Causes of Gall-stone Formation J Exp Med, vol xxxv, p 97, 1924
- <sup>20</sup> Lichtwitz, and Bock Der Kalkgehalt der Gallenblase u seine Bedeutung f d Bildung der Gallensteine D m Woch, vol xli p 1215, 1915
- <sup>21</sup> Andrews and Hrdina Absorption of Calcium from the Gall-bladder American Journal of Med Sci, vol clxxvi, p 478
- <sup>22</sup> Osler Principles and Practice of Medicine Tenth Edition, 1925
- <sup>23</sup> Robb Observations on Calcification of the Gall-bladder with the Presentation of a Case Brit J of Surg, vol xvi, p 114, 1928
- <sup>24</sup> Fowler, W F Calcareous Changes of the Gall-bladder Wall ANNALS OF SURGERY, vol lxxviii, p 623, 1923
- <sup>25</sup> Talbot P Cholelithiasis Notes on a Case with a Calcified Gall-bladder Brit J of Surg, vol viii, p 533, 1920

Diaphragmatic hernia is no longer considered a surgical curiosity. Many of these hernias are discovered as a result of X-ray examinations and may be without symptoms. In other cases the symptomatology fairly definitely points to a hernia. In other cases symptoms are quite too vague to make the average clinician think of a diaphragmatic hernia. And in addition we would call attention to diaphragmatic hernia as an occasional cause of a secondary anaemia.

CASE I—Mrs M. B. F., aged sixty-two years. The significant points of her history were that she had been married thirty years, had had no children, and recently had gained in weight. There was no history of a disease of the digestive tract early in life.

Three years before coming under observation she noticed progressive weakness and loss of energy. Then she consulted a physician who found that she was quite anemic. At that time digestive symptoms were lacking or at least indefinite. Even under treatment she grew weaker and the anemia did not improve. Shortly before coming under observation in 1927 she began to have epigastric distress with occasional attacks of vomiting. She never noted tarry stools nor did she vomit blood. An earlier series of X-ray pictures gave no indication of gastric pathology. The X-rays taken at St. Luke's Hospital in 1927 showed abundant evidence of gastric deformity but were hard to interpret. There was a large residue in the stomach in six hours and a small pocket of bismuth was located at the cardia. This small mass disappeared before the emptying of the main portion of the stomach. Both carcinoma and ulcer were considered in the diagnosis. Hemoglobin

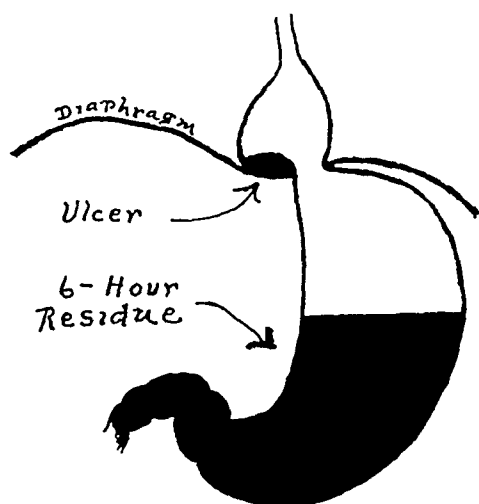


FIG. 1.—Diagrammatic representation of X-ray condition in Case I.

preceding operation. In September, 1927, when the patient was sixty-two years of age, there was revealed by operation a diaphragmatic hernia with an ulcer of the lesser curvature of the stomach. There had at no time been characteristic ulcer symptoms. The oesophageal orifice in the diaphragm was about two inches in diameter and perhaps one-third of the stomach prolapsed into it and was with difficulty and only partially drawn down into the abdomen. A discreet mass was found at the lesser curvature. A strip of omentum turned up over the colon and stomach and was adherent to the mass. The omentum was first detached and then the stomach was drawn down with difficulty until the mass was entirely in the abdomen. A crater was then felt in the lesser curvature penetrating into the gastro-hepatic omentum. The mass was discreet and presented a hard margin with a central thinner portion. The diameter of the ulcer was thought to be about 2 centimetres. There were no large nodes and the condition was not thought malignant. Though the ulcer could be drawn out of the hernial ring, when the traction was relaxed, it re-entered it so as to be just within the grasp of the ring of the diaphragm. Resection of the ulcer was thought impossible and a gastroenterostomy was made because of the large six-hour gastric residue. The immediate convalescence was uneventful. The anemia has greatly improved and the patient is now—four years later—practically free from symptoms.

*December 19, 1930—Cystoscopy—*Cystoscopic examination shows moderate congestion at the trigone. The catheters pass easily to the kidney pelves. Rontgenogram with the catheters *in situ* shows the right pointing farther than usual toward the left side. Pyelogram reveals a normal right kidney pelvis.

*December 23, 1930—X-ray examination of the gastro-intestinal tract shows marked herniation of stomach through the inner aspect of the left diaphragm. At the site of the constriction there is considerable irregularity. It is difficult to determine whether this is due to an inflammatory condition in this region or whether it is the condition of a super-imposed new growth. At the sixth hour there still remains some fluid in the stomach. At the twenty-fourth hour a considerable amount of the medium remains in the irregular area mentioned above. There is also a trace in the stomach proper. At the seventy-second hour emptying is still incomplete.*



FIG 4—Case II A—Thoracic B—Abdominal stomach C—Omentum

*December 26, 1930—Examination of the stomach, including the screen findings, shows the œsophagus directed somewhat to the left, emptying into the stomach above the diaphragm. There was no definite evidence of a diverticulum of the œsophagus at the time of this examination.*

*Laboratory Findings—December 15, 1930, the urine showed nothing abnormal except a faint trace of albumen.*

*December 15, 1930—Red blood-cells—3,500,000, hemoglobin, 53 per cent, white blood-cells, 16,800, polymorphonuclears, 68, lymphocytes, 32.*

*December 18, 1930—Blood urea nitrogen, 14.6 milligrams per 100 cubic centimetres. Blood sugar, 112 milligrams per 100 cubic centimetres.*

*December 28, 1930—Stool for ova and parasites negative. Stool for blood, 1 plus (Guaiac).*

*December 30, 1930—Gastric analysis, fasting contents only. Quantity of contents expressed—40 cubic centimetres.*

anterior wall of the stomach. The free margin of the omentum was adherent to the pericardial sac and to the upper surface of the diaphragm. Its mid-portion was tightly adherent to a large, indurated area on the lesser curvature of the stomach at the point where the lesser curvature made contact with the medial crus of the œsophageal opening of the diaphragm. The entire stomach itself was rotated anteriorly and upward on its transverse axis. The liver had likewise been rotated somewhat and pulled medially by the gastrohepatic ligament. The right kidney was absent from its usual position and was found much nearer than usual to the mid-line. Apparently, it had participated in the general movement of the viscera toward the œsophageal hiatus.

The greater part of the stomach was easily reduced. The lesser curvature, however, was extremely adherent to the medial margin of the œsophageal hiatus. After its removal the stomach was found to have an ulcer at this point. The ulcer had pene-



FIG 6—Case II. Stomach laid open. Ulcer shown at A.

trated the stomach wall completely and had invaded deeply into the gastrohepatic ligament. (Figs 5 and 6.) In the center of the ulcer a blood clot was found projecting from a vessel which presumably had been the source of hemorrhage.

The kidneys were adherent to their capsules and showed the changes of chronic interstitial nephritis. The ureters were normal.

No notable pathologic changes of consequence were present in the other abdominal viscera, except one free stone in the gall-bladder.

The principal points of interest in this case are

(1) The existence of a diaphragmatic hernia containing a large part of the stomach which was the seat of an extensive ulcer. Few of the symptoms usually attributed to either condition were present.

(2) The principal complaint was that of pain in the right lower abdomen radiating along the general course of the right ureter. A possible explana-

## TUMORS OF THE DIAPHRAGM

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ALTHOUGH in recent years improved radiologic technic has made possible the more frequent recognition of hernia of the diaphragm and caused among surgeons an increased interest in this organ, as yet there has been hardly any mention in the literature of primary tumors of the diaphragm. A search in the literature of the past fifty years reveals but four instances of primary tumor, two of which were discovered at operation and two post-mortem. The reports of these are as follows:

CASE I—BONAMY, in 1912, reported a case of multiple fibromyoma. A woman of thirty-four, otherwise well, had noticed for some months a swelling in the right hypochondrium which had recently increased in size. It was situated along the lower margins of the eighth, ninth, and tenth costal cartilages, was dull on percussion, globular in form, and appeared continuous with the liver. It was apparently fluctuant and was diagnosed as an hydatid cyst. At operation, an incision was made in the right hypochondrium over the middle of the tumor, and a large, bluish-white mass was found extending under the costal cartilages toward the xiphoid cartilage. Puncture revealing no fluid, the mass was freed and found to be attached to the diaphragm by a pedicle. It was easily enucleated, then four other smaller ones were found and enucleated. Together they weighed 1,200 grams. Histologic examination showed firm connective tissue with a few striated muscle fibres. The patient had a normal recovery.

CASE II—SAUERBRUCH, in his textbook on surgery of the chest, reports briefly the case of a woman, forty-three years of age, upon whom he operated in 1913 for a tumor in the left hypochondrium. It apparently was the cause of abdominal pain rather indefinite in character, projected below the costal margin on inspiration, and tended to disappear with expiration. In removing it, the eighth, ninth, and tenth ribs were resected. The tumor was found to be a fibromyosarcoma of the diaphragm. The patient recovered and "remained free from recurrence."

CASE III—Of the two primary tumors discovered at autopsy, one was a sarcoma reported by DALZELL in 1887. It occurred in a woman of forty-two years who died three weeks following a fracture of the shaft of the femur, the result of a metastatic deposit in the bone. At autopsy the right half of the diaphragm was more or less replaced by a mass measuring  $1\frac{1}{2}$  to 2 inches in thickness, adherent to and somewhat infiltrating the under surface of the lung. There were secondary nodules in the liver, two tumors in the skull, and one at the seat of fracture of the femur. Microscopically, the primary and secondary tumors were of the same character, masses of small round cells in a fibrous meshwork—evidently a round-cell sarcoma.

CASE IV—CLARK, also in 1887, reported a lipoma of small size, discovered at autopsy in a woman of sixty-five.

My interest in this subject was aroused by the following experience:

AUTHOR'S CASE—In October, 1929, I was asked to see in consultation a male patient in the medical wards of the Boston City Hospital. He was fifty-eight years of age and had a negative previous history except that two years before he had taken a trip to South America. His present illness began five months before entrance with



intermittent attacks of pain in the upper and inner aspect of his right arm. Physical examination was generally negative but examination of the chest showed a small area of dullness and diminished respiration in the mid-clavicular line from the second to the fourth ribs on the right side. An X-ray examination of the chest showed a rounded area of density in the same region of the upper lobe of the right lung, and marked elevation of the right diaphragm (See Fig 1). This latter shadow gave the impression of a rounded tumor below the diaphragm. At this time there were brief spells of coughing and the raising of a little mucus. The sputum was negative for tuberculosis, the blood picture was normal and the Wassermann test negative. There had been no loss of weight.

The signs in the upper chest, and X-ray picture suggested a tumor in the lung, but the evident tumor in the liver and the history of having visited tropical countries pointed to the possible diagnosis of echinococcus disease of lung and liver. An effort to obtain material for a complement fixation test was unsuccessful. On consulting the literature of echinococcus disease I found that a combination of liver and lung hydatids is more common than any other two foci, occurring in about 20 per cent of cases involving the liver, and that pain in the arm and shoulder sometimes occurs in liver cysts. In this case, therefore, we concluded that the pain was reflex through the phrenic nerve, resulting from pressure on the diaphragm by the enlarged liver.

To determine the relation of the diaphragm to the liver shadow pneumo-peritoneum was carried out, 100 cubic centimetres of air being injected, and fluoroscopic examination made at once in the sitting position. The air bubble appeared distinct between liver and diaphragm (see Fig 2), the latter appearing high but freely movable. While this examination was being carried out the patient remarked that his pain was entirely gone. As none of the novocaine had been injected into the peritoneal cavity we concluded that the liver tumor was the cause of his symptoms, and operation was advised. Accordingly on October 24, 1929, laparotomy was performed under spinal anesthesia. On exposing the liver, it was found to be cirrhotic, the surface much roughened and grayish in color. No cyst or tumor of the liver was present, but beneath the posterior part of the right diaphragm was felt a hard, nodular mass about 4 by 10 centimetres in size, evidently growing in the diaphragm and projecting somewhat from its inferior surface. As the growth was obviously malignant and secondary to the tumor in the lung, and could not be excised by the abdominal route, a small piece only was removed with the aid of the electric cautery, which proved on microscopic examination to be carcinoma.

The patient was relieved of his symptoms following the operation for about two weeks. On the return of pain, phrenicotomy was performed with partial relief only. X-ray treatment was begun, but soon a swelling appeared beneath the right clavicle, evidently an extension of the lung carcinoma into the chest-wall. This caused increased pain in the whole arm and demanded an alcohol injection of the brachial plexus for relief. The patient was then transferred to the State Hospital for Cancer where it was hoped he might obtain further relief by special X-ray therapy, but he rapidly weakened and died in January, 1930. Autopsy showed the lung tumor to be a carcinoma of bronchial origin, and the tumor of the diaphragm to be secondary.

*Diagnosis*—The lack of any characteristic symptoms will probably prevent the diagnosis being made in most cases of primary tumor. Secondary involvement occurring in tumors of the chest-wall will often be suspected by the size and position of the tumor, if not demonstrated by X-ray before operation. Hedblom, in 1922 analyzed a list combined of cases in the literature and from the Mayo Clinic—a total of eighty-four cases—in which the diaphragm was found involved and was resected to a greater or less extent.

# SYMPTOMS AND PHYSICAL SIGNS INDICATING HERNIA OF THE DIAPHRAGM WITH REPORT OF TWELVE CASES TREATED BY OPERATION

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THE symptoms of hernia of the diaphragm are odd because of their variety and complexity. Occurring with so many other affections, they readily admit of erroneous interpretation. So fantastic are the chest symptoms and physical signs that a competent internist interpreted his observations in Case I as moderately advanced pulmonary tuberculosis. By others, the attacks of cyanosis were thought to be due to heart disease and the cough to bronchitis. In Case V the prevailing pre-operative opinion was indigestion, obstinate constipation, and later, acute obstruction, probably intussusception. In Case VI the attacks of cough and cyanosis were attributed to pertussis. In Case VII gastro-intestinal upsets were thought to be due to dietary errors. In Case VIII the last physician called, one of six, alone suggested a Röntgen-ray study. This evidence is indicative of failure to consider the possible presence of hernia of the diaphragm from the history and physical examination. In Case XII, for example, the patient was found in a tuberculosis sanitarium. She had been sent there by examiners in one of our state clinics.

In adults the clinical picture of diaphragmatic hernia is often so bizarre and bears resemblance so closely to the symptoms of other diseases of the heart, lungs, stomach, gall-bladder, and intestines that this deformity is not among the examiner's thoughts when he makes the diagnosis by elimination. In infants cyanosis is so often a manifestation of enlarged thymus or congenital heart disease that any other cause is seldom considered. Yet cyanosis is an invariable accompaniment of congenital hernia of the diaphragm and differs clinically from that due to enlarged thymus and heart disease. It is less constant, occurs in attacks, is more likely to appear with crying spells, and is promptly relieved by passing a stomach tube or by changing the patient's posture from the recumbent to the erect. The cough associated with congenital hernia of the diaphragm is peculiar. It may be mistaken for bronchitis, pneumonia, or whooping-cough. It is usually unproductive. When it comes on in paroxysms, it seldom ends with vomiting, is invariably relieved by putting the patient upright, and lacks the characteristic "whoop" of pertussis.

Hernia is sometimes confused with eventration of the diaphragm. Case VIII came to us with the diagnosis of eventration. It may be found extremely difficult or impossible to differentiate the outline of a high diaphragm because of its thin walls. The graceful curve of a rib margin may be mistaken for the diaphragm line. However, with the aid of the Bucky diaphragm the

the stomach is in the left pleural cavity, the position of the heart will depend upon the amount of food or gas in the stomach

On auscultation there is a mixture of sounds. When collapse of the lung is complete or nearly so, there may be an entire absence of breath sounds on the affected side. Instead, sonorous râles are heard. To one accustomed to listening over the abdomen, they sound similar to those heard in chronic intestinal obstruction as gurgling, blowing metallic sounds synchronous with peristalsis. These sounds may be heard high in the chest cavity indicating definitely that they are not transmitted from below the diaphragm.

Finally, the all-important agent of examination, the Röntgen-ray is brought into play. A series of rontgenograms after the opaque meal removes nearly if not all doubt about the position of the stomach and intestines. A barium enema in addition to the bismuth meal should be included in the examination. It is always important to define the location of the colon. The use of the fluoroscope greatly aids in the study of the transposed organs.

*Treatment*—A vast amount of investigation is necessary to obtain evidence upon the incidence of diaphragmatic hernia. That it sometimes exists throughout life without causing symptoms has been demonstrated at post-mortem examinations, that it has been discovered at autopsy as an obscure and unrecognized cause of symptoms is also well known, and that it is frequently unidentified and treated from infancy to old age for a variety of better-known ailments is one of the features of the anomaly.

Since the manifestations of diaphragmatic hernia are as variable as the form of hernia itself, medical treatment is usually symptomatic. Though some form of medication may be indicated it is a mistake to administer drugs to stimulate the heart or respiration. Such treatment within all probability will aggravate discomfort. Bearing in mind the mechanic effects produced by the transposed hollow viscera involved in the hernia and the tendency for peristalsis to be impeded at the aperture in the diaphragm it is natural to infer that a reduction in the volume of gas contained in the stomach and colon would afford immediate relief. This may be accomplished first, by placing the child in upright posture and later, if necessary, by passing a stomach tube or rectal tube or both. In infants and young children a rubber catheter serves the purpose of a stomach tube. An ordinary enema will usually deflate the colon. Regulation of diet helps most patients whether young or old. Antifermentatives may be used to advantage. When drugs and diet fail, the rubber tube can be relied upon to afford instant relief, though it is but temporary.

In a consideration of the indications for an operation of repair, certain precedents governing the treatment of hernia elsewhere may be applied. Hernia at the umbilicus or inguinal region appearing soon after birth is due to developmental failure. Some defects close and remain so permanently. Others close partially or not at all, thus leaving a gap in the supporting layers of the abdominal wall, protected only by a thin serous membrane lining the skin. Hernia develops. If uncomplicated, it is treated expectantly.

employed a pressure apparatus of his own design in Cases VII, VIII, and IX of our series. Respiration was maintained throughout the operation in such a manner as to facilitate the operation, enhance recovery, and maintain convalescence without the occurrence of pleuritic effusion.

In Case XI we have an illustration of the difficulties arising from the use of an anæsthetic which does not give muscular relaxation when needed.

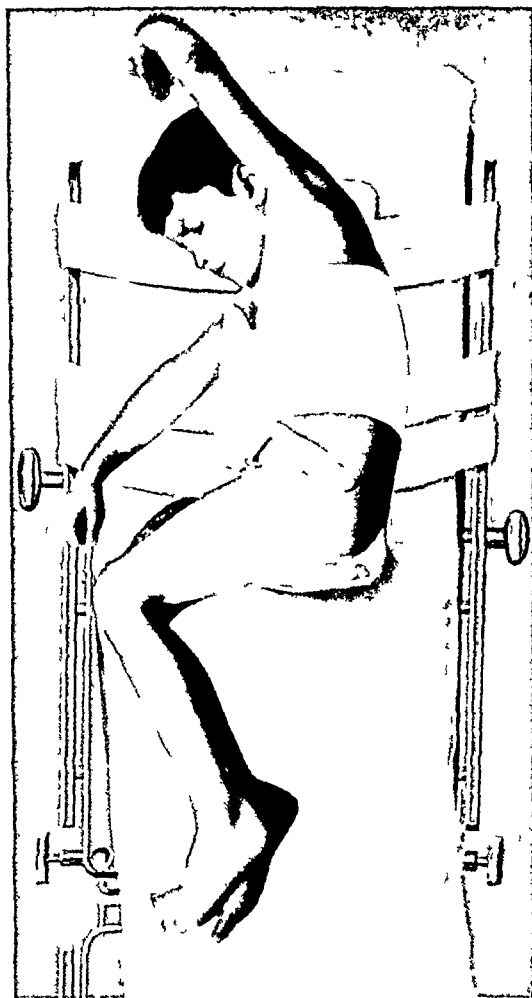


FIG. 1.—A right angle adjustable seat on the operating table supporting the patient in a sitting position.

It is natural to ask why there should be muscular relaxation during operation by the intercostal approach. The operator's experience in this case is an answer to the query. Patient XII was operated upon at the Veterans' Hospital in Washington, D. C. Associated with the writer was Dr. James F. Mitchell. During the operation we found reduction of the herniated stomach and intestines exceedingly difficult. Whenever the stomach was reduced the intestines were forced back into the thoracic cage. An attempt then made to reduce the intestines resulted in the return of the stomach to its former position above the diaphragm.

This is a very discouraging phenomenon and may force the surgeon to abandon the operation. The repetition of this obstacle proved distressing until a simple explanation suggested itself. Gas-oxygen-ethylene was the combination anæsthesia employed. Although the abdominal muscles were remote from the field of operation, their rigidity compressed the abdominal wall and reduced the capacity of the abdomen.

Ether was substituted for ethylene whereupon the abdominal wall relaxed, the cavity enlarged, and the transposed viscera found adequate room when returned to the abdomen and remained there. The loss of time and the strain upon the patient may have been a contributory factor in the development of post-operative pneumonia. If so, it was a costly lesson which afforded the opportunity for an observation of no little value. Spinal anæsthesia has been suggested, but its effects on respiration already crippled are not devoid of added risk.

*The Operation*—In approaching the diaphragm the aperture in the chest

the heart (B) the left lung, (C) the stomach, (D) the small intestine, (E) the colon, (F) the omentum (G) the spleen, and (H) the diaphragm

At this stage in the operation an important step is the anæsthetization of the phrenic nerve to release tension and immobilize the diaphragm. The nerve is displaced outward and rendered taut by the use of a hook. A 2 per cent solution of novacaine is injected into the nerve sheath (Fig 3.) A disturbing element in the operation is the continued action of the heart, lung and diaphragm. Reduction of the herniated organs is greatly facilitated if any one of these embarrassing factors is controlled.

After a general survey of the field, observations may be made on the posi-

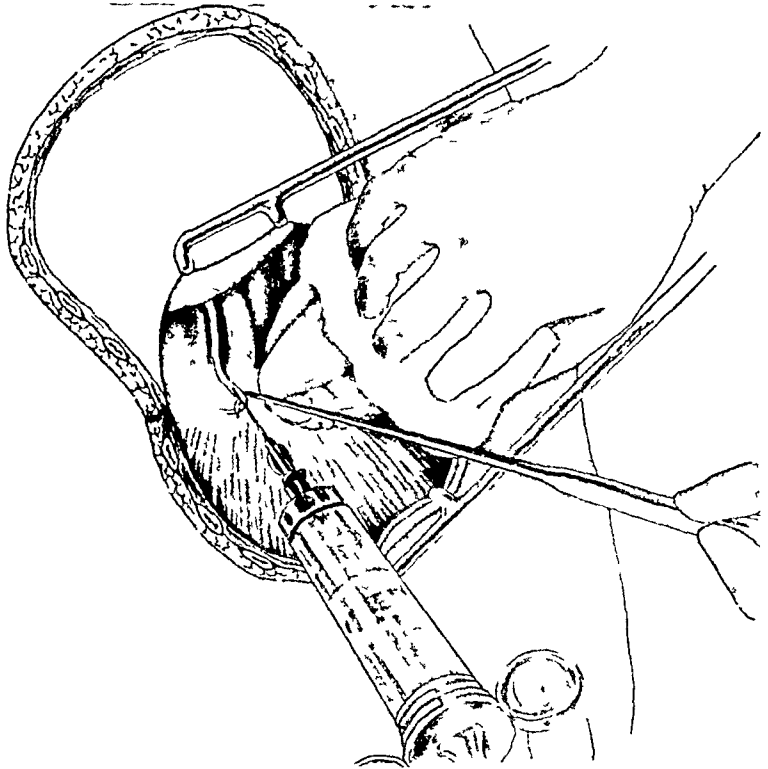


FIG 3.—Injecting the phrenic nerve with 2 per cent novocaine

tion of the heart, the degree of lung collapse, and the condition of all the organs involved in the hernia, such as the degree of distention of the hollow viscera, color of the visceral peritoneum, and adhesions which are likely to prove barriers to reduction. Finally the aperture in the diaphragm should be examined as to its location and size. If there is impaction of those structures which have passed upward from the abdomen the opening is enlarged by an incision beginning at its outer circumference and extending laterally parallel with the muscle fibres for from 5 to 7 centimetres. The edges of the opening are then held back. The enlarged aperture greatly facilitates the chore of tucking the hollow viscera back into the abdomen.

Case	Name	Age	Sex	Other Birth Anomalies	Type	Side	Site	Cause	Duration	Dominant Symptoms	Mistaken For	Diagnosis Made by	Operation	Operative Approach	Contents	Anesthetic	Result	End Result and Remarks
1	Leonard Stone	5 yrs.	M	None	Traumatic (False)	Left	Para-esophageal	Motor car	7 mos.	Cough Cyanosis	Pulmonary tuberculosis	Stethoscope	Feb. 23, 1921	Thoracotomy	Stomach Spleen Left lobe of Liver Small intestine Colon	Pressure Gas Oxygen Ether	Recovery	Recurrence
2	Leonard Stone	6 yrs.	M	None	Recurring (False)	Left	In scar		2 mos.	Intestinal obstruction		X-ray	Cecostomy Dec. 1, 1921 Repair Jan. 17, 1922	Thoracotomy	Transverse colon	Pressure Gas Oxygen Ether	Recovery	Recurrence
3	Leonard Stone	7 yrs.	M	None	Recurring (False)	Left	In scar	Casting	3 days	Intestinal obstruction		X-ray	Cecostomy Nov. 20, 1922 Repair Dec. 5, 1922	Thoracotomy	Transverse colon	Pressure Gas Oxygen Ether	Recovery	Recurrence
4	Leonard Stone	8 yrs.	M	None	Recurring (False)	Left	In scar		2 days	Intestinal obstruction		X-ray	Cecostomy Apr. 10, 1924 Repair Apr. 23, 1924	Thoracotomy	Transverse colon	Pressure Gas Oxygen Ether	Recovery	No further recurrence 4 yrs.
5	Alice Brown	6 yrs.	F	None	Traumatic (False)	Left	Foremen Bochdalek	Casting	12 mos.	Intestinal obstruction		Exploratory operation	Preliminary Appendicectomy Apr. 26, 1926	Thoraco-peritoneal	Colon	Pressure Gas Oxygen Ether	Recovery	3 failures after laparotomy
6	Anna Cifelli	5 yrs.	F	Heretip	Traumatic (False)	Left	Para-esophageal	Motor car	2 mos.	Cough Cyanosis	Whooping Cough	X-ray	May 18, 1928	Thoracotomy	Stomach Spleen Small intestine Colon	Pressure Gas Oxygen Ether	Recovery	Well
7	Lydia Messier	52 yrs.	F	None	Congenital (True)	Left	Esophageal	Develop- mental	Years	Gastric	Gall Stones	X-ray	Repair Dec. 7, 1929	Thoracotomy	Stomach	Pressure Gas Oxygen Ether	Recovery	Well
8	Pauline Lewis	1 yr.	F	None	Congenital (False)	Left	Esophageal	Develop- mental	Since birth	Tetanus of coughing Gastric Bronchitis	Improper feeding	X-ray	Repair Jan. 21, 1930	Thoracotomy	Stomach Spleen	Pressure Gas Oxygen Ether	Recovery	Well
9	Diane Stone	1½ yrs.	F	None	Congenital (False)	Left	Foremen Bochdalek	Develop- mental	Since birth	Abdominal pain and distention from intestinal obstruction	Improper feeding	X-ray	Cecostomy July 28, 1930 Repair Aug. 4, 1930	Thoracotomy	Stomach Colon Small intestine Redimentary lung	Pressure Gas Oxygen Ether	Recovery	Well
10	Helen Walden	52 yrs.	F	None	Congenital (True)	Left	Esophageal	Develop- mental	Years	Gastric	Neurasthenia Cholelithiasis	X-ray	Excision of Gastric ulcer Oct. 11, 1930 Repair Oct. 25, 1930	Laparotomy for Stomach ulcer Thoracotomy for hernia	Stomach	Pressure Gas Oxygen Ether	Recovery	Hernia co-existing with gastric ulcer
11	Charles Frates	34 yrs.	M	None	Traumatic (False)	Left	Esophageal	Motor car	14 mos.	Cough Dyspnea Chest pain Epigastric pain Swallowing		X-ray	Repair Nov. 15, 1930	Thoracotomy	Stomach Small intestine Colon	Pressure Gas Oxygen Ether	Died 7th day Pneumonia	
12	Legia Gausia	12 yrs.	F	None	Congenital (False)	Left	Foremen Bochdalek	Develop- mental	Since birth	Cough Epigastric pain	Pulmonary tuberculosis	X-ray	Repair Jan. 30, 1931	Thoracotomy	Small intestine Colon	Pressure Gas Oxygen Ether	Recovery	Well

possible, two or three layers of definitely fibrous tissue rather than the peritoneal tissue which is often approximated and which does not hold.

DR PHILEMON E. TRUESDALE said he believed œsophageal hernia could be dealt with more conveniently or more efficaciously by a transthoracic approach. It seemed to him that it could. He had attempted the operation from below and failed. He had done the operation from above, providing more adequate room for the use of both hands in the pleural cavity by a two-rib or three-rib resection. In this manner one can operate with a considerable degree of facility at or near the œsophageal opening.

Moreover, it seemed to him that in dealing with hernia through the abdominal wall, ordinarily one operates from above toward the peritoneal cavity and not through the peritoneal cavity out into the sac. The same principle might well hold true in dealing with an œsophageal hernia where the sac extends into the pleural cavity.

He had a patient, a woman aged fifty-one, who came to the clinic for a gastric disturbance. She was anæmic, apparently from loss of blood, which she had noticed in her stools. Her general condition was good, and she appeared to be of a sturdy type. The Roentgen-ray examination revealed a diaphragmatic hernia involving the cardiac end of the stomach. He decided to investigate the stomach from below, and found that she had an ulcer high on the lesser curvature and that the cardiac end of the stomach had herniated through an œsophageal opening. He excised the ulcer by the Balfour method. About three weeks later, through a transthoracic operation, he reduced the stomach from its position in the pleural cavity and then closed the gap. She is now back at her occupation, after eight months, and appears to be well.

Silk is the suture to use in these cases, because any form of catgut softens and swells. It is elastic and, with the constant motion of the diaphragm, may yield to slight tension.

DOCTOR TRUESDALE further said that Doctor Mathews made the statement that hernia of the diaphragm is no longer a curiosity. He believes this is unquestionably true. Nevertheless, it is still considered so rare that it is liable to be overlooked. When the symptoms are abdominal they are usually mistaken for chronic intestinal obstruction, ulcer of the duodenum, cholecystitis, pancreatitis, or some other lesion of the gastrointestinal tract. When the thoracic symptoms predominate they are sometimes mistaken for bronchitis, whooping cough, pneumonia, pleurisy, or heart disease.

the first barrier—the fence as it were, of the carotid group. The bacteria may have taken a circuitous course, going through or around the carotid nodes without stopping.

There arises the very important question of the relation of the infected cervical lymph-nodes to pulmonary tuberculosis. In the first place, as these nodes drain into the jugular trunk, and thence into the venous system, there is no direct path of communication between them and the tracheobronchial nodes, nor is there a direct lymphatic connection between them and the apex of the lung. Much work has been done to elucidate the reason why there is so much tuberculosis of the pulmonary apices, but it is not entirely conclusive. Grabfield and van Zwaluwenberg,<sup>1 5</sup> and later Grabfield and the author,<sup>6</sup> have worked on the study by roentgenograms, of the occurrence of involvement of the apical pleura in instances of disease of the cervical nodes. The figures are not conclusive, but we have thought that there was an increase in the thickness of the apical pleura (so-called pleural caps) in these cases. All we can say is that this thickening is suggestively greater in cases of cervical tuberculosis and it would be a simple theory if it could be substantiated.

A careful observation of many cases leads us to the conclusion that in a large number of instances the tuberculous nodes in the neck constitute the primary locus of disease after it has passed the tonsils and adenoids. This statement does not, of course, leave out of consideration earlier instances of infection, but we believe that for the period of infection of which the enlarged nodes are a manifestation, those nodes constitute the primary locus. In other words, in the cases as we see them, the infection is not deposited in the lymph-nodes from the blood-stream, as might result from a pre-existing focus in the lungs, but is carried directly to them from the pharynx. Therefore, these nodes are a primary focus, and a central distributing station from which tubercle bacilli may be carried into the blood-stream and thence around the body. If this is correct, early extirpation of the nodes would be, in certain instances, not only a proper therapeutic but a proper prophylactic measure.

The diagnosis of this type of tuberculosis often presents to us a difficult problem, because so many cases have no symptoms or signs except a swelling in the neck, and there may be nothing to suggest whether we are dealing with tuberculosis, lymphoblastoma, branchial cyst, or any one of many other less common tumors. Although our ability to make a correct diagnosis of tuberculosis improves as our experience becomes greater, a scrutiny of our operative records would reveal examples of the following conditions in which a diagnosis of tuberculosis was incorrectly made—Hodgkin's disease, actinomycosis, branchial tumors, neuro-fibromas, secondary cancer, syphilis, subacute non-tuberculous infection, mixed tumors of the salivary glands, and even perithelioma of the carotid body. In cases in which diagnosis is difficult we always recommend biopsy, feeling that the attainment of a correct diagnosis is far more important than the consideration of the minor cosmetic problem of a small scar in the neck. In patients with active pulmonary tuberculosis the occurrence of enlarged cervical nodes should not, it seems



GROUP I

*Treatment with Tuberculin and Lamp Therapy*  
(57 Cases)

Improved, 26, 45 per cent, Not improved, 18, Doubtful, 13

We use no internal medication except cod-liver oil and tomato juice, which we prescribe almost always

With Rontgen-ray therapy our experience has been too limited to allow us to offer any conclusions of value. The most extensive recent review of the subject was published by Hanford<sup>9</sup> in 1927, and he says "Small doses of filtered Rontgen-ray given at intervals of less than three weeks appear to shorten the course of the disease and to favor resolution or marked improvement in all stages (except cold abscesses) in a sufficiently large percentage of cases to justify the conclusion that the Rontgen-ray is useful in the treatment of tuberculous glands of the neck"

Hanford notes that the cases most helped are those with tuberculous sinuses, and those with small lymph nodes, and that 40 per cent of cystic swellings resolved without incision or spontaneous opening. He found that of 141 patients 47.5 per cent were apparently cured in an average of ten months, and 23.4 per cent were "so markedly improved when last seen as to make the treatment appear satisfactory." He adds that other methods of treatment, minor and major surgical operations, should be employed when indicated.

In the early days of our use of the X-ray we found our enthusiasm dampened by the case of a young man with very extensive tuberculous nodes on both sides of the neck, in whom a series of treatments with the Rontgen-ray was followed by a rapid subsidence of the nodes and coincidentally an equally rapid miliary tuberculosis and unexpected death. One could not say, to be sure, that the treatments were responsible for the result, but the sequence of events was so striking that it was very difficult to convince one's self that such was not the case.

A series of unselected cases in which various methods of treatment were used, including a few with X-ray, is given in Group II. These cases include minor operations, heliotherapy and other measures.

GROUP II

*Treatment by Various Methods*  
(110 Cases)

Improved, 52, 47 per cent, Not improved, 21, Doubtful, 19, Partly improved, 10, Recurrences, 8

We now come to the question of surgical treatment, and here at once we enter on debated ground, a sort of no-man's land. Let me repeat that I refer to cases in which the cervical tuberculosis is the only clinically active focus of disease, particularly those cases in which there is no pulmonary disease.

Incision and drainage are indicated when the node, or nodes, have broken down and the overlying skin is red and the tumor is fluctuant. The drainage,

both the patient and ourselves into a sort of false hope, a hope that, more often than not, failed to be realized. Then I personally saw four cases, in young and otherwise robust people, which progressed from what seemed to be localized disease in the neck to most tragic consequences, two young women, and one young man, under our conservative treatment, developed severe pulmonary or generalized tuberculosis and died, while the fourth, a young woman, is in a State institution with extensive pulmonary disease. So far as we could determine, in these four instances the primary focus of the then active disease was in the neck, and, rightly or wrongly, it seemed to us that early removal of those nodes might have saved the patients.

At just the time when we were crystallizing our ideas in regard to the advantages of surgery, Hanford,<sup>11</sup> of the Presbyterian Hospital, and Clute,<sup>12</sup> of the Lahey Clinic, announced independently the same conclusions. Clute wrote "For the average patient, who cannot afford the time or expense of prolonged hygienic treatment, surgery seems the method of choice." With this we heartily agree.

Operation will not, of course, be suitable for all cases. It should be reserved for those with fairly discrete masses, preferably rather early in the course of the disease. If there are nodes on both sides of the neck, the operation may be done in two stages. It is never necessary to do the extensive dissections with removal of the sternomastoid muscle as was formerly done, and as is indicated in cancer, and if the incision is made parallel with the natural creases in the neck, the scars will not be too unsightly. The spinal accessory nerve, the most important one which is encountered, can always, with care, be spared. Recurrences do take place, but the fear of this possibility should not make one forego operation. We believe that the operation *per se* does not cause the dissemination of tubercle bacilli throughout the body.

The technical details need not be described here. The removal of an extensive group of enlarged and adherent nodes is not a task, to be sure for the inexperienced, but in the hands of a careful and well-trained man, it is a procedure more likely to do good than harm.

The results of an unselected series of radical operations is given in Group III. These figures seem at first glance to be hardly any better than those in the other tables, but they do, in our opinion, represent a much more satisfactory group of results than the others.

### GROUP III

#### *Treatment by Radical Excision* (89 Cases)

Improved, 46, 51 per cent, Recurrences, 23, Doubtful, 16, Other tuberculosis, 4

When one comes to discuss the treatment of enlarged cervical nodes in a patient with active pulmonary disease or miliary tuberculosis, the question is a different one. We believe that operation should not be performed unless the tumor is causing symptoms, such as pain from pressure of the swelling, or apparent toxic sequelæ, or having a bad mental effect on the

the incision can be covered by a string of beads, or at least so it will not be very conspicuous

In regard to injuring the spinal accessory nerve it is readily possible to find the spinal accessory nerve by dissecting carefully down the posterior border of the sternocleidomastoid muscle, the spinal accessory nerve penetrates the muscle and can easily be found as it comes through the muscle. One can follow it up through the group of glands without injury in practically all instances

Another point in regard to the technic is the division of the sternocleidomastoid muscle when necessary. It may be done a very little distance above the clavicle, where one avoids all injury to the nerve supply of the muscle. The nerve supply comes from the spinal accessory and cervical plexus and hits the muscle nerve in the middle of the muscle. If one goes below that damage to the nerve supply of the muscle will be divided

In his own experience he had seen a number of persons die following involvement of the lymphatic glands of the neck in which operation was not done. One was a little boy who had a rather extensive involvement of the glands of the neck. He decided to have an operation because a sister, only a few months previously, had died of tuberculosis spinal meningitis following lymphatic-gland involvement. It is true that a number of cases requiring operation is very rapidly decreasing

He had noticed, too, that since taking up practice in a relatively small city, where the hygienic conditions are good there are really few patients of tuberculosis of any kind as compared with the number of cases he used to work with in Philadelphia, or at the Johns Hopkins Hospital

In certain instances tuberculosis of the glands of the neck will not yield to any form of conservative treatment. The son of a physician came to him a number of years ago who had had everything—the rest cure in the open air, as the patients have at Saranac Lake X-ray treatments ultra-violet-ray treatments, and every other conservative method. He had had five operations, and still was not cured. A thorough incision cured that young man and he has now been well for a number of years

He believed that there are a large number of such cases. He questioned, personally, whether any of the glands that have become definite cases ever cease to be a menace to the patient

DR FRANK S. MATHEWS (New York City) said that at the St. Mary's Hospital for Children in New York the number of new patients per year with cervical-node tuberculosis has dropped from about fifty to less than five in the course of (say) twenty-five years. He was strongly convinced that the disappearance was a question of milk and not of tonsils

He personally had had several patients who had gone to the country for the summer with the idea of preserving the children's health, and were very careful to pick out one farmer and one cow for milk for the children. He recalled three such cases. In one of those cases three acute cases of throat infection followed by tubercular glands, arose. I don't need to mention the other two. But that has been sufficient to demonstrate that in those cases it was a question of giving tubercular milk

He had said that the treatment of tuberculous glands of the neck depended entirely on the specialty of the physician consulted. If he were a tuberculosis specialist, at least a few years ago, he probably would give tuberculin, if it were the general family doctor he would give them hygiene, if an X-ray man he would give them that, even if the glands were calcified, and, finally there is the general surgeon who might want to make them surgical. But all of these groups will turn them over to the general surgeon if they are doing badly, if they are breaking out and causing sinus trouble, they are all likely to step from under

He advocated surgical treatment at the very earliest before the condition gets all over the neck and axilla and becomes suppurative

DOCTOR MILLER, closing the discussion, remarked as to the suggestion of Doctor Tinker that a majority of these cases are due to bovine bacillus, that this has been

## PARACELSUS

By FRED B LUND, M D

OF BOSTON, MASS

IN JUNE, 1527, in Basel, Switzerland, the day before the Feast of St John, which the students of the university were to celebrate by a large bon-fire in the public square, the following notice in large letters appeared on the door of the city hall "The famous Doctor Paracelsus, City Physician, will speak at High Noon tomorrow in the Town Square upon the New and Marvelous Light of Medicine He will also touch upon the Ignorance, the Avarice and the Strutting Vanity of the Doctors of Basel" Exactly at noon Paracelsus appeared He was dressed in a sweeping black silk robe trimmed with red His hat was black and gold He wore a long sword and carried an ebony staff Behind him walked a page carrying two large books bound in leather For a moment he faced the crowd in silence, then strutted up and down the platform, sweeping the flagstones with his robe, showing off his staff, his sword, and his regal stride Then he stopped, tore off his hat and threw it savagely into the audience, slammed his sword on the pavement, broke his staff over his knee, stripped off his robe, rolled it into a crumpled ball and sent it after his hat He advanced toward the crowd bareheaded, in a plain gray jacket, sleeves rolled up to the elbows "Thus," he screamed in his shrill voice, "thus should a doctor appear before his patient—to cure by knowledge, not by fine clothes, by science, not by gold rings and jewels" He motioned to the page who handed him one of the books With a furious gesture, Paracelsus tore it in two and threw it on the furnace It blazed up in a burst of yellow flame and black smoke "That was Galen," he shouted

The second book followed, and a second burst of flame rose up "That was Avicenna," shrieked the heretic doctor "Old bloodless words Vain mouthings of ignorance Latin sounds meaning nothing From these books your doctors get their Latin for diseases they know nothing about and their Greek for diseases they never heard of Gray-bearded frauds, old wormy moth-eaten sophists, lousy pretenders with their fine clothes, their long steps, their Latin to hide their ignorance They cling to the rich like leeches and let the poor die like flies They make a disease out of nothing but a pain in the belly from too much eating And when there is a real disease, they fly from it afraid for their reputations Their cures are worse than the illness They burn the flesh with hot irons, give black draughts which tear at the bowels Their plasters raise blisters as thick as a hand Then they go back to their snug studies, thumb over Hippocrates, that old Greek, and Galen, that old Roman, and count the golden coins they've stolen from your pockets"

great human restlessness which desired what it could not formulate until they came."

Theophrastus Bombastus von Hohenheim was born at Einsiedeln, Switzerland November 10, 1493, a date easily remembered as being one year after the discovery of America. His father was a physician of good family who managed the matron of the pilgrim hospital in Einsiedeln. He was named Theophrastus after the great Greek botanist who followed Aristotle in the Peripatetic School. Bombastus, which one might think from his writings gave the name bombast to boastful writing and speaking, was a family name, formerly Bambast, and did not give the name bombast to the English language, as it has another derivation, von Hohenheim was probably the origin of the latinized name Paracelsus, by which he came to be known, so that the name was not derived from the old Latin encyclopedist, Celsus, with the meaning the second Celsus. He was a small, weak child, difficult to rear, he is said to have had a tendency to rickets. His father kept him in the open air and used to take him for long walks during which he became acquainted with the medicinal herbs in the locality. He said later in his writings "I have to laugh when I think of the German doctors sending to Italy and across the Mediterranean to the Far East for medicinal plants, when God has given such an abundant supply right at home in Germany. The German doctors are Arabs, Greeks and Chaldeans who prefer foreign medicines and know nothing about German medicines, prefer medicines from over seas when they have better remedies in the gardens in front of their houses." There is a story that he was castrated when he was a boy by some drunken soldiers who were billeted in his father's house, evidence has been adduced from his portraits in favor of this story. Considering the man's character and work, it is hard to believe. He was brought up in the fear of God and later wrote much on morals and religion. Probably from his father in his early youth he got his love for the study of nature, which later was to lead him so far afield during almost his entire life. Born, as has been said, in the times of the Renaissance and the Reformation, he imbibed from the one his impulses to the light of nature to scientific induction and comparison, and from the other his religious tolerance. He probably remained always a Catholic, but what he says later about Luther is of great interest. He had been called by some of his enemies in view of his attempted reforms in medicine, "the medical Luther," and this was his answer—"The enemies of Luther are composed to a great extent of fanatics, knaves, bigots and rogues. Why do you call me a medical Luther? You do not intend to honor me by this, because you despise Luther. I know of no other enemies of Luther than those whose kitchen prospects are interfered with by his reforms. Those whom he causes to suffer in their pockets are his enemies. I leave it to Luther to defend what he says, and I shall be responsible for what I say. Whoever is Luther's enemy deserves my contempt. That which you wish to Luther, you wish also to me, you wish us both to the fire."

not published until seventy years after his death, he gave some of the results of his chemical investigations, including chapters on "The Mysteries of the Microcosm, The Mysteries of the Fifth Essence, (Quinta Essentia), The Mysteries of Extractions of Specifics, On Renovation and Restoration, *etc*" He adopted as the elements the water, fire, earth and air of the old philosophy. He was the discoverer of zinc-oxide ointment. In fact, if not the discoverer of zinc, he was the first to use the word in literature. Of zinc and its compounds he gave a very good description. He introduced preparations of iron, antimony, mercury and lead into pharmacology. He investigated amalgams of other metals with mercury, the uses of alum, and the gases arising from solutions and calcination. He considered the three basic principles necessary to all bodies to be sulphur, mercury and salt in his cipher terminology—sulphur standing for fire, mercury for water, salt for earth, otherwise for inflammability, fluidity and solidity. Air he left out, considering it a product of fire and water. He adopted the platonic theory of the Macrocosmos and Microcosmos by which the body of man became an embodiment in little of the universe, and carried it to such ridiculous length as to give to the wind in the intestines in the various kinds of colic the same names as the winds of heaven, Boreas, Eurus, Auster and Notus. When they got blowing against each other or the wrong way, we had a belly ache.

Other results of his experimental research were the chloride and sulphate of mercury, calomel, flowers of sulphur, and many distillations. He guarded the use of all medicines in later treatises by earnest counsel to physicians to know well the diseases for which they were administered. "For," he said, "every experiment with medicine is like employing a weapon which must be used according to its kind: as a spear to thrust, a club to fell, so also each experiment. And as a club will not thrust and a spear will not fell, neither can a medicine be used otherwise than for its own disease. Therefore it is of the highest importance to know each thoroughly and its powers. To use experimental medicines requires an experienced man who discerns between the thrust and the blow, that is to say who has tried and mastered the nature of each kind—The Physician must be exactly acquainted with the illness before he can know with what medicine to conquer it. A wood-carver must use many kinds of tools in order to work out his art. So, as the physician's work is also an art, he must be well practised in the means which he employs."

In his book called "The Book of the Three Principles" (Salt, Sulphur and Mercury), he says that, reduced to their lowest terms, there are only three diseases and three remedies, therefore why the endless nonsense about Avicenna, Mesne and Galen. Diseases should be called by the names of their cure, leprosy, gold disease, being cured by gold, and epilepsy, vitriol disease, because it is cured by vitriol.

After ten months' hard work at Schwatz he left Villach on his travels. He decided that his university experience was as barren of results as if he were in a garden where the trees were all stumps, and that he would trans-

is distributed throughout the whole world It must be sought for and captured wherever it is

"Sicknesses wander here and there the whole length of the world, and do not remain in one place If a man wishes to understand them he must wander too Does not travel give more understanding than sitting behind the stove? A doctor must be an alchemist He must therefore see the mother-earth where the minerals grow, and as the mountains won't come to him he must go to the mountains How can an alchemist get to the working of nature unless he seeks it where the minerals lie? Is it a reproach that I have sought the minerals and found their mind and heart and kept the knowledge of them fast, so as to know how to separate the clean from the ore, to do which I have come through many hardships?"

"Why did the Queen of Sheba come from the ends of the earth to hear the wisdom of Solomon? Because wisdom is a gift of God, which He gives in such a manner that men must seek it It is true that those who do not seek it have more wealth than those who do The doctors who sit by the stove wear chains and silk, those who travel can barely afford a smock Those who sit by the stove eat partridges and those who follow after knowledge eat milk-soup Although they have nothing, they know that as Juvenal says 'He only travels happily who has nothing' I think it is to my praise and not to my shame that I have accomplished my travelling at little cost And I testify that this is true concerning Nature whoever wishes to know her must tread her books on their feet Writing is understood by its letters Nature by land after land, for every land is a book Such is the Codex Naturæ and so must a man turn over her pages"

From France he took ship for Venice, where he spent some time as army surgeon to the Venetians who were engaged in a war with Charles V One of their wars was for the defence of the Island of Rhodes against Suleiman II the Magnificent He mentions a disease which he found among "Saracens, Turks, Tartars, Germans and Wallachians Here he made observations on arrow wounds, the bow and arrow being used no longer in western wars

He then visited the Tartars in the Balkan Peninsula and Southern Russia, and went as far north as Moscow Here among the herds of cattle he learned about the treatment of horses, cattle, sheep and goats He journeyed from Moscow to Constantinople with a Tartar prince He learned from Saracens and Turks the lore of their saints and from Jewish physicians and astrologers the secrets of their dread Kabbala

From Constantinople he returned to Venice in 1522, and again took service with the Venetians in the war between the Emperor Charles V and Francis I, King of France, for the possession of Naples Wherever he went he practiced his new medicine and surgery reviled and abused the physicians of the old school, is said to have successfully treated many patients given up by his colleagues, at least he says he did He remarks "I pleased no one except the sick whom I healed"

"4 He shall at all times be temperate, serious, chaste, living rightly, and not a boaster

"5 He shall consider the necessity of the sick rather than his own his art rather than his fee

"6 He shall take all the precautions which experience and knowledge suggest not to be attacked by illness

"7 He shall not keep a house of ill fame, nor be an executioner nor be an apostate, nor belong to the priestcraft in any form "

The enmity toward him of the regular profession grew worse and worse Doctors, apothecaries, barbers and bath-men banded together against him They called him a "Luther in Medicine," a "liar," a "fool," a "suborner," a "necromancer," and other equally uncomplimentary epithets He replied as follows "The doctors take more trouble to screen their movements than to maintain what concerns the sick, and the apothecaries cheat the people with their exorbitant prices and demand a gulden for messes not worth a penny "

He accepted an invitation in Zurich where his students there gave a banquet in the course of which he addressed them as "*combibones optimi*," and they in return addressed him as "our own Theophrastus " Such apparently was the sole foundation for the charge of habitual drunkenness which was made upon him by his medical colleagues, and was so emphasized and insisted upon that it has lasted to this day

Troubles accumulated for him in Basel His friend and patient Frobenius died He was threatened with assassination They published a lampoon in excellent Latin entitled "The Shade of Galen against Theophrastus, or rather Cacophrastus " It purported to be a letter from Galen postmarked "Hades", a spiteful and scurrilous fabrication it has been called It was nailed to the door of the cathedral, where all might see it Stirred to the depths, he made an indignant appeal to the Town Council He kept quiet in public, but in private invented nicknames for his foes, among the mildest of which were "Doctor Blockhead" for the doctors, and "scullery-cooks" for the apothecaries

He treated at this time a wealthy canon of the cathedral, Leichtenfels by name, who had offered a hundred gulden to any one who should cure him, and only sent for the so-called heretic after the failure of many others Hohenheim got him over his pain and sleeplessness, but he refused to pay more than six gulden Hohenheim sued for his fee and lost his case He was to be outlawed and exiled to an island in Lake Lucerne His friends warned him, and he fled, never to return to Basel Here is part of what he wrote afterward about these colleagues who had treated him so basely in the preface to his book "*Paramirum*" "I am not afraid of them, but I am afraid of the discredit which they will thrust upon me and of the out-of-date Law, Custom, and Order which they calle Jurisprudence "

He went to Alsace and to Colmar, where he visited in the house of Dr Lorenz Fries, who, though a Galenist, was broadminded enough to be-



Burgomaster Christian Studer, who had put himself under his treatment, and continued his work called the "Opus Paramirum." Leaving St Gallen at the end of 1531, he wandered about for many years. At St Gallen he completed the four books of the Paramirum. This remarkable book deals with the Five Entia or causes of disease. I The "Ens Astrale" is the action not so much of the stars as of the climate, the sun and moon, and the weather in general, as influencing the health. II The "Ens Veneni" diseases coming from the poisons arising from the excreted portions of food and drink. (By the way, we have an "alchemist" in the stomach whose duty is to separate the poisons which are to be excreted from the portions of food which are to be absorbed. If he is not on duty, the "Ens Veneni" gets us.) III The "Ens Naturale," diseases arising from Nature including the natural humors, of which there are many more than the four of Hippocrates and Galen. IV The "Ens Spirituale," diseases which come from the spirits of men. *The spirits have hand-to-hand conflicts, so to speak, outside the bodies of their possessors, and the winning spirit can inflict all sort of trouble on the body possessing the loser.* "He is a fool who denies the power of the mind over the body," says our author. Last, there is the "Ens Dei," a class of diseases produced by the direct influence of God in his infinite wisdom. A most interesting treatise. In this book, superstition, religious reverence, and occult learning struggle with exact observation, experiment and common sense, now one wins, now the other. All his works that I have attempted repay reading in the original. The old German is not too hard, the periphrastic and picturesque style and the evident downright earnestness of the man come out much better in the original than in the translation, even if at times one realizes that one does not get all of his meaning.

It seems that the physician must know all about these entia because a disease which comes from one ens may seem to come from another, and the right treatment can only be given if we recognize the causal ens, for the ens spirituale something like the Coue treatment or Christian Science might be the right thing.

Some people think (Stoddart) that Hohenheim had a prevision of the decomposition of light by the prism, but from the passages quoted, that seems to me rather doubtful.

The "Opus Paramirum" closes with a second address to Joachim von Watt, echoing Hohenheim's bitter cry "Who hath believed my report? Strange, new, amazing, unheard of, they say are my physics, my meteorics, my theory, my practice. And how should I be otherwise than strange to men who have never wandered in the sun? I am not afraid of the Aristotelian crowd, nor of the Ptolemaic nor that of Avicenna, but I fear the insults ever thrown in my way and the untimely judgment, custom, order, which they call jurisprudence. Unto whom the gift is given he receives it who is not called I need not call. But may God be with us our Defender and our Shield, to all eternity. Vale."

After finishing the Paramirum, Hohenheim lived for some years in

to Vienna, where he was entertained at a banquet in his honor by the City Recorder, Blasius Beham. In Vienna he again incurred the enmity of the physicians to such an extent that no one would receive his manuscripts for publication.

In 1537 he returned to Villach, received the inheritance left him by his father, and accepted a temporary position as metallurgist of the Fuggers. He studied the mineral resources of the Carinthian Mountains and wrote another book about it. Meantime, he had written a book on Stone, Gravel, Chiragra and Pellagra, which he calls the Tartaric Diseases. He tells his patients that if they will follow his treatment they will avoid "the bloody and uncertain hands of the cutter for stone." This was not published till twenty-two years after his death. He practiced at St. Veit, and there treated the physician to the King of Poland, Albert Basa. His professional foes again bothered him, and once filled the courtyard of the church in order to insult and hustle him as he passed in and out. He travelled for two years longer. Worn out by constant labor and travel, he became ill of some insidious disease, both poisoning and violence were suggested, but not proved.

Sensing the approach of his death he hired a room in an inn in Salzburg and made his will. He left all his medical books, implements and medicines, with the exception of some small money bequests, "to his heirs, the poor, miserable, needy people, those who have neither money nor provision, without favour or disfavour, poverty and want are the only qualifications."

He was buried in the churchyard in the burial place of the poor. He was engaged in religious writings during the last days before his death. Fifty years later his body was removed to a new resting place against the wall of St. Sebastian's Church. This is the inscription on his grave: "Here lies buried Philip Theophrastus, the famous doctor of medicine, who cured wounds, leprosy, gout, dropsy and other incurable maladies of the body with wonderful knowledge, and gave his goods to be divided and distributed to the poor. In the year 1541 on the 24th day of September he exchanged life for death."

Within the forty-eight years of his turbulent life were crowded enough laboratory work, experiment, study, travel, practice and trouble to make a dozen ordinary lives. He loved his God, loved the poor and loved his profession. His superstition, credulity and turbulent spirit were a part of his time. He had much to arouse his just indignation. He believed, however, from the beginning to the end, in observation and experiment and the study of nature and disease as the basis of practice. For these principles he worked, fought and wrote with irrepressible zeal. Many of his contributions to medicine have been mentioned above. He has been called the father of homeopathy, and of many other things. He was surely the first to insist upon the importance of travel and observation in many parts of the world for the equipment of the physician and surgeon. In this sense he may be considered the father of all the societies for medical pilgrimage which have done so much for their members in our time. Many have not yet learned

## A CASE OF THYROIDITIS SIMPLEX (REIDEL'S TUMOR)

BY HERBERT A. BRUCE F.R.C.S., ENG.

OF TORONTO, CANADA

ONE of the most interesting of the pathologic conditions encountered in the thyroid gland is that type of inflammation described by Reidel in 1896 to which his name is attached. The patients nearly all seek relief from the pressure symptoms produced by the goitre which as a rule, begins when relatively small to produce dyspnoea, dysphonia and dysphagia. This is evidently due to the way the hard tumor attaches itself to the structures of the neck. The cause is not known. Shaw and Smith, writing in the *British Journal of Surgery* in 1925, state that the cases examined were negative for tubercle bacilli, spirochetes and the common forms of bacteria.

The patient was a spinster of forty who had been employed as a secretary for many years. Her previous health had been good with the single exception of having had slight menorrhagia. She has pronounced views regarding foods, and eats very little meat. Eleven months previous to admission she noticed an enlargement of her thyroid, about which she worried a great deal, chiefly on account of its appearance. Her basal metabolism was normal. She had a mass of fibroids in her uterus. The thyroid gland was considerably enlarged, nodular, quite hard and mobile. Thyroidectomy was performed under local anaesthesia on November 11, 1926, when three-quarters of both lobes were removed.\*

Following the operation there was slight infection of the wound due to the staphylococcus aureus, which was very slow to respond to treatment but otherwise she made a good recovery, and seven weeks later a sub-total hysterectomy and appendectomy were done, from which a splendid recovery was made.

She enjoyed good health for nearly three years, when she again noticed enlargement of her neck, and felt a constriction about it, especially on lying down. This worried her a great deal and caused loss of sleep and nutrition. These symptoms became so aggravated that a second operation was advised in July, 1930.

The dissection was very difficult on account of firm adhesions, but two lobes, one 3 by 1½ by 1 inches, the other 1½ by 1 by 1 inch, with a small central portion the size of a filbert were removed, leaving now only the posterior capsule. She made a good recovery, but soon showed signs of thyroid deficiency, which were controlled by small doses of the whole gland.

The pathologist reported that the tissues showed a very diffuse granulomatous type of inflammation, consisting of proliferative changes in the stroma, infiltration of endothelial cells, as well as lymphocytes and plasma-cells. Diagnosis—Reidel's Struma.

Her symptoms have been entirely relieved and she is now in good health.

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\* These were filled with small adenomata.

The 1,066 cases may be roughly grouped as follows

- 444 hyperplastic goitres with 3 deaths, 0.67 per cent mortality
- 410 toxic adenomata with 5 deaths, 1.2 per cent mortality
- 200 non-toxic adenomata with 0 deaths, 0 per cent mortality
- 5 thyroiditis (including 2 abscesses of thyroid) with no deaths
- 7 carcinomata with 1 death, bringing the total of fatalities to 9

Death in these cases was due chiefly to the heart. Five of the nine fatal cases had auricular fibrillation and three others had dilated and de-compensated hearts upon entering the hospital. Cerebral embolism was responsible for two deaths, one patient dying two hours after operation from this cause, and one as she was leaving the hospital on the eighth post-operative day. The only death from hæmorrhage and shock came two hours following the operation, as the result of the removal of a large substernal carcinomatous goitre. One exophthalmic case, a young woman whose condition was too desperate for lobectomy, died following a ligation.

The average age of those dying of toxic adenomata was fifty-eight and one-half years, the youngest forty-eight and the oldest sixty-seven years of age. These figures substantiate Crile's statement that the mortality in this type of thyroid surgery occurs almost always after the fifth decade.

The age of those dying of the hyperplastic type, in our series, was considerably younger. The average was thirty-seven years, the youngest twenty-one, and the oldest forty-eight.

Of the seven carcinomata of the series, three had symptoms for less than one year prior to consultation. Little could be done to improve the mortality in this type, but four had goitres of from twenty to sixty-five years' duration and the average age at time of examination was fifty-nine years. Had these four had thyroidectomy for their symptomless goitres prior to the age of fifty they might have been saved.

Only two of the seven cases were operable and these are alive and well today, both having had practically total thyroidectomies followed by radium. One inoperable case lived one and one-half years, his life prolonged considerably by the use of radium, one died two and one-half months following a tracheotomy for obstruction by the growth, two others died within four months after the use of radium, and we have lost track of the remaining case.

The mortality rate is roughly proportional to the duration of symptoms prior to operation. In the adenomata but one death occurred with enlargement of less than ten years' duration, and four deaths in the cases of from ten to fifty-two years' standing. In the hyperplastic type there were no deaths in cases with symptoms of less than one year. Two of the fatalities occurred in old recurrent goitres, one with symptoms for five, and the other for eight years.

The average duration of the disease prior to operation, for hyperplastic goitres, was fourteen months, for the adenomata, twelve years. As time

In our experience, unless a temporary hypothyroidism results post-operatively a recurrence is likely later on

Five minims of iodine daily are given post-operatively to the hyperplastic type for from one month to six weeks. Regeneration of thyroid tissue is delayed or prevented to a certain degree by this means

To secure ideal results in the hyperplastic type, as much gland should be removed as possible without injuring the parathyroids or the recurrent laryngeal nerves

One nerve was injured in four cases of the present series. In spite of our most careful efforts, this unfortunate accident will happen at rare intervals. The surgeon is invariably warned by a change in the respiratory note when this accident occurs, and should proceed with the greatest of caution on the other side. In recurrent goitres, in large substernal or retrotracheal goitres, and in rare cases of unusual position of the nerve, injury is most apt to occur. We have seen a dissection of the recurrent nerves by Doctor Foster, of the University of Oregon Medical School in which the course was directly superior and internal to the lateral lobes. In such a case trauma to the nerves could scarcely be avoided.

Where but one nerve is injured no permanent damage results as the remaining cord eventually acts as efficiently as both, though a hoarse or husky voice may be present for some time. If both are injured a bilateral adductor paralysis of the cords eventually results, and they assume a constant position of adduction, leaving insufficient breathing space. This may occur as early as six weeks or as late as six months post-operatively. An intense dyspnoea follows which must be relieved by a permanent tracheotomy. Though many measures, such as cordectomy, laryngeal fissure resuture of the nerves, *etc* have been attempted, they are rarely sufficiently successful to warrant their trial. Permanent tracheotomy seems to be the only effective treatment.

Exophthalmus was found to be present in 42 per cent of the hyperplastic cases. Post-operatively, when present, this symptom disappeared on an average in six months in 75 per cent of the cases and persisted in 25 per cent to some extent to date.

Only three cases in this series had symptoms of tetany of sufficient severity to require medication. Tetany may be divided for convenience into acute and chronic varieties. The acute type comes on within twenty-four hours after the operation, with symptoms of numbness and tingling in the tongue, fingers and toes, carpo-pedal spasm, and even generalized epileptiform convulsions. The blood calcium drops below normal and the Chvostek and Trousseau signs become positive. These cases are controlled by parathormone intravenously, massive doses of calcium lactate by mouth, calcium chloride intravenously, cod-liver oil with Viosterol and sunshine. Within a week or ten days the oedema and swelling, which have rendered the circulation to the parathyroids insufficient, will have subsided, and the patient recovers.

## THE END-RESULTS OF THYROIDECTOMY

BY FREDERICK A. COLLIER, M.D. AND EUGENE B. POTTER, M.D.  
OF ANN ARBOR, MICH.

GOITRE has undoubtedly been the subject of more careful study by surgeons during the past decade than any other lesion, with the happy result that, due to a wider knowledge of the disease, better selection of cases, meticulous pre- and post-operative care, refinement of operative technic, the mortality from surgical treatment in the hands of the experienced has fallen to its ultimate low level and the complications formerly so formidable have largely disappeared. The occasional death after thyroidectomy is commonly due to the neglected disease, rarely to an accident in the treatment. Until etiology of the disease is known, any betterment in our therapeutic results will come from many critical studies of the end-results of surgical and other forms of treatment. Some such studies have been made, but when one considers the vast volume of the literature on goitre, one is struck by the relatively small amount of attention given to this important phase of the subject.

In order to check up our results in the University Hospital with the view to determining the efficacy of surgical treatment for goitre in general and to find our errors in particular, an attempt has been made during the past year to get in touch with the patients with goitre of all types treated by operation during the four-and-a-half-year period from August 1, 1925, to December 31, 1929. An effort has always been made to keep in touch with these patients at least four times during the first year after operation with a considerable degree of success, but after that we tend to lose touch with them as time lapses. The conditions were not ideal for the study as our patients often live at long distances, they are often financially unable to return for re-study and they are frequently lost track of because of changes of residence. Questionnaires were mailed to them which they were asked to fill out, also they were urged to return for examination. When this was impossible, we arranged for many of them to be examined by their family physicians. Practically all patients with residual symptoms and all who were unrelieved were reexamined by a physician. Basal metabolic studies were made whenever possible either in the clinic or by some other laboratory situated near their homes and were secured on a large number. We were able to get personal or fairly satisfactory check-ups on only 733 patients of about 1,200 treated during this period, consequently we do not have the value of reports on a consecutive series of patients. We are aware of the inadequacy of any method of study of end-results short of frequent, complete examinations with laboratory studies of all patients treated, but in spite of its shortcomings, we feel that this study is of some value in evaluating the degree of rehabilitation in these patients. The opinion of the

exophthalmic goiter were studied. They were an average group of patients, the general facts concerning whom are shown in Table I. The ratio of males to females is roughly 1 to 2, average age 37.6 years and the average duration of symptoms 14.6 months. The average gain in weight was 27.6 pounds at the time of reexamination over the weight at the time of their arrival in the hospital. Excluding patients with recurrences, six patients lost an average of eight pounds while fifteen had no change in weight. Most patients make an astonishing gain in weight during the first few months

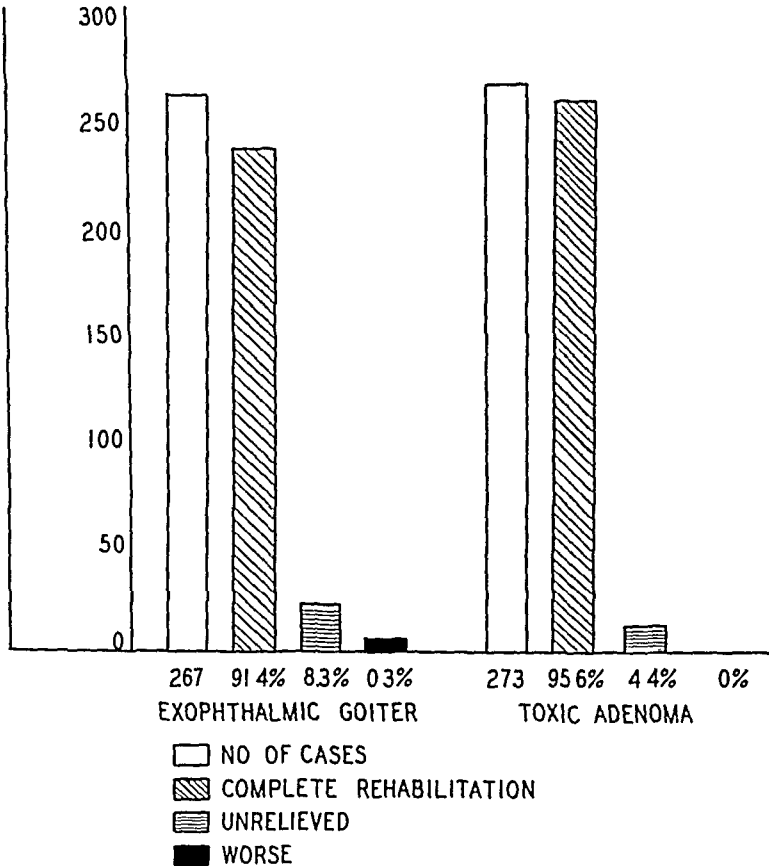


TABLE 2 GRAPHICAL REPRESENTATION OF REHABILITATION  
IN PATIENTS WITH HYPERTHYROIDISM

after operation, often so much as to be objectionable, but during the following year, usually without conscious alteration in diet, they attain their normal weight. A large part of the weight gain is due to lowered basal metabolic rate but some of it is due to a continuation of the appetite and eating habits acquired during their period of hyperthyroidism. The acquisition of obesity plays no part in the restoration to normal and after normal weight is restored it is wise to see that they are on a diet that meets simply their caloric needs.

In estimating the end-results of thyroidectomy we feel it was not enough to consider only the basal metabolism and to call a patient cured if this was

stances the exophthalmos, while still present, was very much less marked than before operation, in many cases hardly noticeable. Persistent exophthalmos was most common in patients in whom the disease was of long standing. The disappearance of a marked exophthalmos was usually rapid to the point of a slight exophthalmos after which the complete return of the eye and ocular muscles to normal took several months. Operative treatment, early in the course of the disease, offers the best chance of obviating the appearance of exophthalmos and also the best chance of returning the eyes to normal after this sign is present.

A voice difficulty was the only complaint in nineteen or 71 per cent. The larynx is carefully examined before and after operation and there was












CASES - 267	
COMP REHABILITATION	
UNRELIEVED	
WORSE	
NO RESIDUAL SYMP	
RESIDUAL SYMPTOMS	
EXOPH ALONE	
EXOPH AND CARD SYMP	
SUBJ CARD SYMP	
VOICE DIFFICULTY	
TOTAL RECURRENCE	

TABLE 4 GRAPHICAL REPRESENTATION OF RESULTS  
AND MORBIDITY IN EXOPHTHALMIC GOITER

post-operative unilateral laryngeal palsy present in two patients both of which cleared up in three months, therefore the voice symptoms were not due to nerve injuries. The complaints are of a mild functional type, such as "Voice more easily fatigued with use," "singing voice not as good," "voice not as strong," "a sense of pressure in the neck with prolonged use of voice." Some of these complaints are undoubtedly functional or neurotic in origin but there must be an anatomical basis for many of them. The extrinsic muscles of the larynx may be the site of scar tissue or may be more or less fixed by scar probably accounting for these mild vocal difficulties which are not of particular importance except to point out the necessity of preserving muscles as well as nerves if one wishes to avoid all symptoms of this type.

The commonest residual group of symptoms was referable to the cardiovascular system. Seventy-one patients or 26.8 per cent complained of sub-



has marked uterine prolapse and another large fibroids that may play a part in producing symptoms. Two women were in the menopause and had nervousness that probably was due to this rather than the residue of the disease. Two patients had complaints of chilliness and mental dullness with basal metabolic rates of  $-15$  and  $-14$ , while no gross symptoms of myxedema were present, they both felt better when taking thyroid therefore they were classed as hypothyroid.

More than half of the patients who were unrelieved had had their metabolic rates returned to normal by the operation but were unrelieved because of permanent heart disease or by totally unassociated lesions that may have been aggravated by the disease or at least associated with it in their minds.

The one patient who was made worse has permanent tetany subsequent to the operation. Two other patients in the entire group had transient tetany that disappeared within two weeks. No positive signs of it were found on any other patients either in the hospital or during the examination.

*Recurrence*—There were thirteen or 48 per cent recurrences in the entire group. Five of them had second operations in the period under consideration and are now completely relieved with one exception that of a woman who now has a second recurrence. The other eight still have the recurrent disease or have had the second operation too recently to evaluate fairly. The recurrences fall into two definite classes. Nine of them who had recurrence within six months had had the disease in a severe form with a large goitre. The operation was not adequate and one may say that the disease was not arrested and rather than a recurrence one must regard it as a continuation of the disease. The others were really recurrences after an adequate operation that restored the patient to normal only to have a return of the goitre and the disease after the lapse of several years. Recurrences of this type were found always in people who because of social conditions were driven to return to hard work a few weeks after operation. The time elapsing between operation and recurrence varied from one to five years. An example in point is the woman of thirty-eight who in 1926 had her original operation with complete relief. The disease returned in 1928 when a second operation was done with again complete relief. She had a recurrence again in 1931. She is the mother of a large family and is obliged to support the family by her own efforts which mean long hours of drudgery with great mental worry. We have operated upon a woman who had been operated upon nineteen years ago and who had a recurrence after this length of time. From our observations we feel that the so-called recurrences due to leaving too much thyroid gland, which is most likely to happen in those patients with large glands and with a severe form of the disease must be regarded as a failure of the operation to halt the disease and are a continuation of the disease rather than a recurrence. True recurrences in which the disease returns after a restoration to normal by operation are often found to have, as an exciting cause, overwork, worry, anxiety or infections.

Fifteen per cent of these patients were iodine-resistant which was due in many instances to the prolonged use of iodine in an attempt to cure the disease before they are subjected to surgical treatment. The use of iodine in the hope of cure has also prolonged the duration of the disease before operation in many instances, increasing the operative risk and leaving the patient with residual symptoms, the presence of which might have been prevented by earlier surgical treatment.

*Adenomatous Goitre with Hyperthyroidism*—As seen in Table I this group were on the average nearly a decade older than the patients with exophthalmic goitre. The disease occurred far more frequently in women, the ratio of males to females being 1 to 5. Goitre had been present in an average of 15.6 years while the symptoms had been present for much larger periods than in the exophthalmic goitre group, on an average of 43.7 months.

TOXIC ADENOMAS  
273 CASES

COMPLETE REHABILITATION	UNRELIEVED	WORSE	NO RESIDUAL SYMPTOMS
263	10	0	32
132 (48.3%)	HAD NO RESIDUAL SYMPTOMS		
131	GOOD RESULTS HAD RESIDUAL SYMPTOMS AS FOLLOWS		
4 (1.4%)	EXOPHTHALMOS ALONE		
7 (2.5%)	EXOPHTHALMOS AND CARDIAC SYMPTOMS		
86 (31.9%)	SUBJECTIVE CARDIAC SYMPT		<div style="display: flex; align-items: center;"> <div style="border-left: 1px solid black; padding-left: 5px; margin-left: 5px;"> TACHYCARDIA ARRHYTHMIA PALPITATION </div> <div style="margin-left: 10px;">} 34.4%</div> </div>
6 (2.1%)	SLIGHT ENLARGEMENT OF NECK WITHOUT TOXICITY		
28 (10.4%)	VOICE DIFFICULTY (NOT LARYNGEAL PARALYSIS)		

TABLE 6 DATA ON PATIENTS WITH TOXIC ADENOMAS

The longer duration of symptoms before seeking surgical treatment is due to the insidious onset and the milder character of the symptoms. The average gain in weight after operation is 24.6 pounds. On reexamination two remained with weight unchanged and five had lost an average of four pounds.

As shown in Tables VI and VII the total number, 273, all except ten were able to return to their usual life. Of those rehabilitated, 132 or 48.3 per cent of the total were free from every symptom. The remainder of the group, 131 in number, had mild residual symptoms from the disease or operation. Eleven of them showed very slight eye signs which were not of any real consequence. True exophthalmos was a very uncommon finding in any of these patients, even prior to operation.

A greater number, 10.4 per cent, complained of minor voice difficulties without evidence of nerve paralysis. The larger number than in the exophthalmic goitre group may be due to the fact that the adenomatous goitre

*Adenomatous Goitre without Hyperthyroidism*—Thyroidectomy is done on this group for cosmetic reasons as a prophylactic measure and for pressure symptoms. A study of the end-results suggests that they are also relieved of many mild symptoms that may be due to an altered thyroid secretion. The average age of these patients was thirty-three years while the goitre had been present for sixteen years. This group is essentially the same as the adenomatous goitre with hyperthyroidism except it is a decade younger with, on an average, a much larger goitre. Hyperthyroidism would probably have developed in many of them if the goitre had not been removed. Ninety-four and five tenths per cent of them were well pleased with the results of thyroidectomy, in fact many of them were so enthusiastic that we took special care to see why they felt so. About half of them had pressure symptoms due to the presence of a tumor in the neck. Palpitation and dyspnoea were present in over 80 per cent, often ascribable to pressure but present many times when no distortion of the trachea existed. Nearly every patient complained of nervousness of some more or less vague subjective type, such as apprehension, irritability and mental tension. A weight loss was present in more than half the cases while muscle weakness and vague digestive symptoms were present in many. These symptoms did not incapacitate but they were at least uncomfortable and a distinct departure from the normal. In other words, we found evidence that goitre with normal basal metabolic rates were associated with many definite symptoms. Most of these symptoms disappeared after thyroidectomy as shown by the high percentage who were symptom-free after the operation. An argument has been advanced against operation for this type of goitre with a normal basal metabolic rate that there will be produced myxoedema if the goitre is removed since part at least of the function must be coming from the goitre. A comparison was made of the basal metabolic rates of these patients before operation and a varying period in years after operation and we found them to be essentially the same. A special study<sup>1</sup> was made of seventy patients whose basal metabolic rate was in the lower limits of normal and the check determination showed 54 per cent to have a lowered rate of an average 4.6 points while 46 per cent showed an average gain of 6.7 per cent—points which enable one to prophesy that the basal metabolism after thyroidectomy for adenomatous goitre with a normal metabolism will remain essentially the same.

Myxoedema was encountered in only one instance in a patient on whom an operation for a recurrence followed a lobectomy done years previously. No patient was found to have true myxoedema associated with a goitre. These observations demonstrate the ability of almost any amount of thyroid or goiterous tissue to maintain a normal metabolic rate. Oftentimes in removing the degenerating adenomatous goitre it is impossible to leave anything except abnormal adenomatous tissue which is perforce left as a cover for the parathyroids and the nerves, but even this scanty amount of abnormal tissue is adequate to maintain a normal metabolic function.

recurrences after a period of normal health. These are due to the action of an exciting cause, most commonly overwork and worry. A third group who have normal metabolic rates are those who were ill-chosen for operation or who come for operation too late and who were incapacitated by permanent damage to vital organs. There is, in general, a ratio between the results of operation and the duration of the disease. Quite as important is careful post-operative supervision with insistence on a period of rest. Operation should be an incident in the medical care of the disease which should be carried on for a long period of time after operation. Operation may not be a cure but it enables most of the patients to return to work within a comparatively short space of time and prevents the development of permanent visceral damage. The poor results are due to refraining from operation rather than actually operating. It is unfortunate that a mathematically accurate amount of thyroid cannot be left by the surgeon since even though the thyroid has a great compensatory power the line between producing myxœdema and failure to check hyperthyroidism is a fine one. Too much harsh comment has been passed on recurrence which is the least harmful of the complications of errors in judgment as to the amount of thyroid left. A second operation in an occasional case is preferable to myxœdema or tetany with the inevitable cataracts in many cases.

In the patients with adenomatous goitre with hyperthyroidism, the results can be improved appreciably if the patients will come to operation earlier in the disease. The higher incidence of slight residual subjective cardiac symptoms is due to the longer course of the disease and the older age of the patient. It is probable that thyroidectomy, at some time in the fifteen years that the goitre is present before symptoms of hyperthyroidism appears, will prevent most of the symptoms referable to hyperthyroidism.

Thyroidectomy for adenomatous goitres with normal basal metabolic rates gives a high percentage of good results. Aside from pressure symptoms there appear to be many mild symptoms that are relieved by thyroidectomy. After the removal of goitre of this type the basal metabolic rates will not change importantly and there need be no fear of producing myxœdema.

At some future time a specific treatment for exophthalmic goitre may be discovered, until that time operative treatment offers a low mortality and high percentage of rehabilitation. For other goitres that are of long standing, surgical treatment offers prophylaxis from hyperthyroidism and other complications and a high degree of rehabilitation after the complication of hyperthyroidism has occurred. Procrastination in carrying out operative treatment, frequently bears the responsibility for the residual symptoms.

#### CONCLUSIONS

(1) Subtotal thyroidectomy for exophthalmic goitre gives rehabilitation in over 90 per cent of the cases.

(2) Of all cases treated by operation about 65 per cent had no important

# PROGRESSIVE EXOPHTHALMOS FOLLOWING THYROIDECTOMY, ITS PATHOLOGY AND TREATMENT

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THE exophthalmos which is characteristic of a certain type of goitre usually subsides following operative treatment of the gland, ordinarily it is not a matter of any great concern to the surgeon, nor does it require special treatment. In occasional instances, however, this protrusion of the eyes may not subside after operation and may then constitute a disturbing residual symptom of the disease. In still other instances exophthalmos after thyroidectomy becomes progressive and the literature is filled with instances in which this has occurred. Among the reports of particular interest are those of Zimmerman,<sup>1</sup> Burch<sup>2</sup> and Roeder and Killins<sup>3</sup>. This condition has resulted, in extreme instances, in total blindness. Enucleation of the eye is often necessary because the protrusion advances to such a degree that the lids are no longer able to cover the cornea, and desiccation abrasion and ulceration with infection result from exposure. Some of these patients show choking of the discs and atrophy of the optic nerves, though this is by no means an invariable accompaniment of the exophthalmos. Ophthalmologists have recommended various procedures for protection of the eye, such as suturing the lid and canthotomy. In other instances, operations upon the cervical sympathetics or the stellate ganglion have been tried upon the theory that the principal factor in the production of the exophthalmos is an over-activity of the sympathetic nervous system, producing its effect upon the involuntary muscles in the orbit. The operations upon the lid, as might be expected, have met with no success and have had no effect upon the progress of the protrusion. Sympathetic operations likewise, while resulting in a slightly narrowed lid slit and a smaller pupil, have been quite inadequate and unsatisfactory.

An inquiry into the cause of the exophthalmos associated with hyperplastic goitre indicates that there is no concurrence of opinion as to the underlying mechanism. There have been numerous proponents of the idea that certain muscles supplied by the sympathetic nervous system have become over-active and, in one way or another, are responsible, not only for the exophthalmos, but for the wide lid slit and the lagging of the upper lid in following downward movements of the eyeball. The muscles of Muller,<sup>4</sup> Landstrom,<sup>5</sup> and Krauss<sup>7</sup> all have been considered to play their rôles, the muscles of Muller and Landstrom by acting directly upon the globe, and the muscles of Krauss by constricting the ophthalmic vein so as to produce a venous engorgement, which secondarily has been responsible for the prominence of

directed toward determining the presence or absence of such a lesion. Her neurologic examination proved to be entirely negative and encephalograms confirmed the opinion that there was no gross abnormality in her nervous system, her spinal fluid pressure was normal. Measurements with an exophthalmometer read 34 on the right side and 32 on the left side.

It was decided that the protrusion of the eyes could not be explained on the basis of any intracranial lesion and there was no evidence of intraorbital tumor or arterio-venous aneurism. In view of the fact that the loss of vision was progressive and the exophthalmos still increasing, it was felt that a decompression of the orbit offered both an opportunity at once to relieve the exophthalmos and perhaps to determine its cause. A satisfactory explanation of the changes in the optic discs could not be made in the light of our present knowledge, but it was felt that they must be associated with whatever pathologic condition was producing the exophthalmos.

*Operation*—April 7, 1930 a right frontal operation was performed. The dura was elevated from the orbital plate, which was then opened. The orbital roof was ronguered away widely to give a maximum decompression of the orbital content. The bone was removed mesially as far as the ethmoid and sphenoid cells, and anteriorly as far as the frontal sinus. Laterally the entire plate was removed, and posteriorly, it was removed to the greater wing of the sphenoid. The orbital content bulged markedly through this opening and obviously was under extreme tension. The orbital fascia was opened and the orbital content was exposed. Fat was visible toward the mesial and lateral sides of the orbit, but, upon palpation, it was evident that it was not under tension as contrasted with the tension within the cone of extra-ocular muscles which passed forward from their origin about the optic foramen to the globe. Upon palpation, the tension of this muscle cone was extreme. We felt that the explanation for the exophthalmos must lie here and decided to open through the muscle and to explore the retrobulbar space for the cause of the pressure. Small sutures were introduced into the levator superioris to act as retractors and the muscle fibres were split longitudinally. As the incision was continuously deepened, it was found that, instead of dealing with the normal muscle, perhaps  $1\frac{1}{2}$  millimetres in thickness, we were in a deep muscle mass, and the incision had to be deepened to about  $1\frac{1}{2}$  centimetres. This muscle was greatly increased in size, was perhaps a little paler than normal, and was distinctly fibrous. This splitting of the muscle was continued forward to the sclera, and its margins were retracted. We were then able to explore the retrobulbar space and the optic nerve as it entered the sclera. No veins and no fat were found within this space. The entire space was filled by this bulk of extra-ocular muscles. Small portions of the muscle were removed for microscopic examination.

With these findings before us, the explanation for the protrusion of the eye was clear. It was caused by an increase in muscle volume. The reason for the changes in the optic discs was not so easily seen. It was considered as a possibility that some constriction about the optic foramen by this same mass of muscle might be a factor in the disc changes. For that reason, it was decided to continue the decompression of the orbit to include the optic foramen and, with this in mind, the bony roof of the optic foramen was ronguered away. The muscle incision was then continued back to the point of origin of the muscle at Zinn's ligament—the fibroperiosteal ring about the optic foramen from which these muscles take their origin. The muscle splitting was continued back to include their origin and the optic nerve was exposed. The muscle became progressively more fibrous and even gritty to the knife and additional portions were removed for microscopic examination. Following the complete decompression of the orbital contents and the optic nerve, the dura of the frontal lobe was allowed to come down upon the orbital contents, the bone flap was replaced and the wound was closed. It was obvious at once, upon the conclusion of the operation, that the right eye had receded markedly. The following day there was considerable œdema of the

slightly by tying the external jugular veins Dr Margarete Kunde<sup>9</sup> of the Department of Physiology of the University of Chicago, has reported, in her experimental work upon rabbits, that exophthalmos could be produced if a thyroidectomy were performed upon three-weeks-old rabbits, if these rabbits were later fed with thyroid No examination of the orbital contents has been reported in these animals This we hope to present to you at a later time from our own and her experimental work It is noteworthy that most of the patients who are described in the literature as suffering from progressive exophthalmos have had a normal or low basal metabolic rate as is the case in Doctor Kunde's experimental animals The patient now reported had a low metabolic rate and had been given thyroid Also it was noted that an unusually broad collar incision had been made at the time of her operation, and that both external jugulars had been tied In view of the fact that the venous return from the orbit has a double channel to the systemic circulation one by an intracranial route, and the other through communicating veins to the facial vein, this might be one factor in the production of the protrusion The changes Brooks<sup>10</sup> reported in the presence of marked obstruction of venous return flow from muscles in the extremities were similar to those found in this case of progressive exophthalmos

It is hoped that experimental work now under way may throw additional light upon the mechanism of these muscle changes and also add a link to our understanding of the circulatory changes seen in choking of the optic discs

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of metastasis strongly suggests that malignancy is commonly spread at the time of the operation

The type of current used determines the effect produced. The rapid-cutting current seals only capillaries and small vessels, *per primam* healing may follow its use even in the skin, while with gland or muscle the healing is apparently as good as with the knife, microscopic section shows only a slight layer of surface coagulation. Slow-cutting current is more effective in arresting hæmorrhage but causes more tissue destruction. The coagulating current causes almost instantaneous clotting for a considerable distance along vessels, while slow coagulation may be used to cook and destroy a considerable area. A non-absorbable surface is formed and superficial cells are killed at the same time that cutting of tissue and sealing of vessels occurs. The non-absorbing surface and coagulated vessels not only prevent metastasis but also prevent thyroid crisis by avoiding absorbing thyroxin

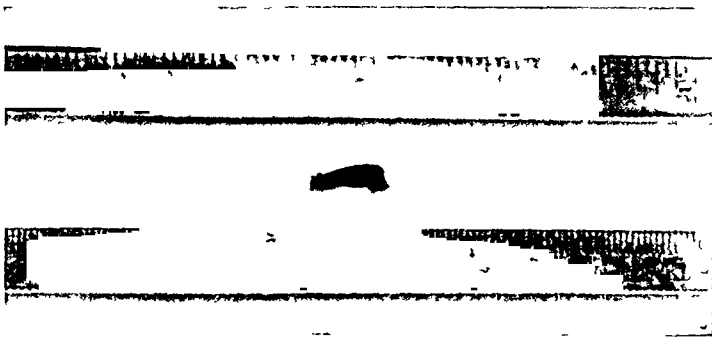


FIG 1—Shows the size of vessel which can be coagulated safely in some cases also length of clot in centimetres and inches

from the wound. The killing of superficial cells avoids local implantation of cancer cells and also minimizes the risk of infection. The question was raised by Crowell<sup>5</sup> whether these advantages are real or theoretical. That electro-coagulation actually does seal vessels is apparent to anyone with much experience in using it. If a blood-vessel be isolated, clamped and touched with the coagulating current, a clot forms instantly which usually can be seen by all at the operating table and which if desired can be made to extend for one-half an inch or more along the vessel. To show this I had such a section of blood-vessel photographed between two scales, metric on one side and inches on the other (Fig 1). In this instance the clot is well over one-half inch, or fully  $12\frac{1}{2}$  millimetres in length. Such a clot could be dislodged but this would not occur with the pressure ordinarily found in the blood-vessels, even if abnormally high, nor would it be likely to be dislodged by ordinary manipulation. The non-absorbing surface produced by electric-cutting current is shown by histologic section of the cut surface on which can clearly be seen a microscopically thin layer of coagulated tissue (Figs 2 and 3). The advantages of electro-surgery in many operations of surgery, not alone in goitre and malignancy, I have emphasized in



satisfactorily, skin and subcutaneous tissues do not heal so rapidly as if cut with a sharp scalpel. This agrees with Ellis's experimental findings<sup>9</sup> that with dogs the skin healed *per primam* in only 60 per cent with electric cutting and in 97½ per cent with knife wounds while with muscle, for practical purposes, electrically produced and knife wounds healed equally as rapidly and with equal strength of union. Hence it has seemed to me desirable to limit the amount of electric cutting as much as is possible in tissues giving less favorable healing. To obtain the advantages of electro-coagulation which seals vessels much more securely than electric cutting I have in certain operations surrounded the area just inside the line of proposed excision by coagulating punctures, one-half inch apart. Experimental work as previously mentioned shows that electric coagulation extends the clot approximately one-half inch along the vessels. Hence, if punctures are made one-half inch apart it would seem fair to assume that the clotting would extend in a radius of at least one-quarter of an inch surrounding the puncture. It is possible by using the electro-coagulating spatula to puncture down and completely surround certain cancerous areas, effectually closing the blood-vessels and lymphatics so as to prevent metastasis in handling the tissues. The line of skin incision is then made with a scalpel just outside the electro-coagulated puncture line, and in breast-cancer operations the flap is further reflected by using the scalpel. As muscle healing seems to be good with electric cutting, muscle attachments may be divided by the cutting current. How much advantage will be gained by this procedure will have to be determined by experience, but it is certain that the vessels and lymphatics surrounding a growth can be effectually closed in this way.

Two difficulties in the use of electro-surgery are common to other operations than those for malignancy and goitre, these are, first, the difficulty in cutting through thick layers of fat, and, second, the contraction of muscles as they are cut. These difficulties can be obviated to some extent but fat is such a poor conductor of electricity, as well as of heat and cold, that it requires a stronger current and more rapid cutting to divide thick layers of fat. Fortunately the layers of fat are usually subcutaneous and in most cases important vessels and lymphatics through which cancer cells are carried, freeing metastases, are more deeply located, and it is possible with coagulating-current punctures to block off the area adjacent to the malignant growth as I have already suggested in this paper where the cutting current would be much less certainly efficient.

The contraction of muscles caused by electric stimulation when the electric cutting is used would decidedly interfere with careful dissection under certain conditions. In operations like that for breast cancer the attachments of the muscles to the chest wall are readily divided, specially accurate dissection not being required. When one becomes accustomed to working with electric cutting the muscular contraction usually gives little annoyance and is of no practical consequence. Certain makers claim that their apparatus

# PARATHYROIDISM AND PARATHYROIDECTOMY

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**HISTORY**—The connection of parathyroidism with osteomalacic conditions has a most interesting history covering a period of twenty-five years. Much of it has been given in recent publications so that only a brief outline is recalled here. (For closer study of the historical development see Hunter, Barr and Bulger, Compere, *et al*.) Von Recklinghausen, in 1904, first described osteitis fibrosa cystica in a classical paper which brought to the condition the name of von Recklinghausen's disease of bone. In 1909, DeCosta gathered eight cases of parathyroid tumors from the literature, one of them his own. It is interesting that neither von Recklinghausen in his article on osteitis fibrosa cystica mentioned the parathyroids, nor DeCosta in his article on parathyroid tumors, mentioned the connection with skeletal diseases. Askanazy, in 1904, published the first case of parathyroid tumor found post-mortem in a case of osteitis fibrosa cystica. Erdheim, in 1907, saw the two conditions associated three times, and made the first attempt to connect them etiologically, claiming that the parathyroid hyperplasia was due to the effort of the gland to increase calcaemia (Erdheim's theory). Hoffheinz, in 1925, gathered forty-five cases of parathyroid tumors, twenty-seven of them were complicated by disease of the skeleton. In the same year Mandl achieved the distinction of performing the first parathyroidectomy successfully for the cure of osteomalacic conditions. It is interesting to note that Mandl then was not sure at first whether the condition was due to hyper- or hypoactivity of the parathyroids. He tested the matter by first transplanting more parathyroids into his patient and observed a distinct increase in the severity of the symptoms, thereupon he removed the transplant plus the patient's own parathyroids.

**Symptomatology**—The symptomatology of parathyroidism has also been given fully by the same authors mentioned above and by others. Just as myxœdema and Graves' disease are antithetic conditions in the pathology of the thyroid gland, so in the parathyroid, we have two conditions opposing each other, namely, tetany and parathyroidism\*. For the understanding of the condition, however, it is useful to tabulate the opposing symptoms. In tetany, the parathyroids may be diseased, but more often they are injured.

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\* We believe that the word parathyroidism should replace the longer term hyperparathyroidism because thyroidism means the same as hyperthyroidism, and hyperparathyroidism does not tell us any more than parathyroidism. It also reminds us that opposing symptoms are not simply due to lessened or increased function of the affected gland, but that various clinical states will have to be interpreted as dysfunctions with mixtures of hyper- and hypo-elements in the same patient (Ballin and Morse, 1 c.)

The vertebral bodies also become flattened and finally show compression fractures. Frequent fractures of the ribs, vertebræ and long bones should remind us of parathyroidism, especially if metastatic malignancy can be ruled out. Severe pain in the affected bones is practically always present. Some of the patients have spent months and sometimes years in bed, or with corsets and other supports in the effort to relieve this pain. The pain may be caused mostly by pressure on the intervertebral nerves, by the deformed vertebræ, but the hypercalcæmia most likely is the more important underlying factor, judging by the prompt relief which follows operation. The demineralization of the skeleton leads to the increase of the serum calcium, and to increased calcium excretion in the urine. Just as the liver is the storehouse for glycogen, so the spongiosa of the skeleton is the storehouse for calcium. Donald Hunter and several others have written most explicitly on this topic. In parathyroidism the spongiosa of the bones gives out calcium too rapidly. Later in the disease the cortical substances of the bones also suffer. The increased calcium content of the blood is one of the main symptoms of parathyroidism. We find readings up to 20 milligrams (25 milligrams exceptionally), the normal being 8 to 9 milligrams, *however, hypercalcæmia can be temporarily or continuously absent, and if so should not exclude the diagnosis of parathyroidism if all other symptoms speak for it*.

Careful metabolic work on the calcium metabolism has shown that in parathyroidism there is a negative calcium balance, that is the calcium excreted in stool and urine is six or seven times greater than normal. The excretion is greater than the intake, even with high calcium diets and the bones are progressively decalcified. The importance of the changed phosphorous metabolism (lowered serum P) goes with the calcium disturbance, some think it is more important than the calcium.

Metastatic calcium deposits in parathyroidism have been lately emphasized and made a part of the symptom complex through the work of Oppel in Leningrad. It has been proved that such calcium metastases can also be produced by free hypodermic administration of parathormone. In Roentgen-rays taken in parathyroidism, we see large calcium deposits around the bodies of the vertebræ, and anterior-vertebral ligament, the lumbar ligament shows diffuse calcification or calcium deposits. Perhaps the occasional very early deposits of calcium in blood vessels of young people is also due to this endocrine disturbance. Metastatic calcifications have also been found in the mucosa of the stomach, heart, thyroid and adrenal cortex in parathyroidism. Oppel believes that in ankylosing multiple arthritis, the initial focal infection is the nidus for the deposition of lime in patients predisposed to metastatic calcification by parathyroidism. Oppel claims, after extensive investigation, that in practically all ankylosing types of polyarthritis there is a moderate hypercalcæmia, averaging 12 milligrams of calcium per 100 cubic centimetres of serum. His studies have been published after operations on seventy such cases in 1928, and were done in the hospital where Bechterew made his studies.



FIG 1

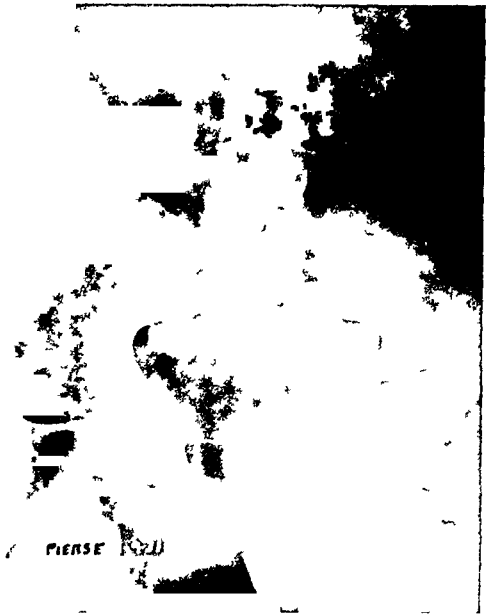


FIG 2

FIG 1—Case XV Female aged fifty two Arthritic pains for five years Height lessened 2 inches Marked kyphosis Blood calcium 12.8-14 milligrams Immediate relief of pain after parathyroidectomy Area between arrows indicates demineralized and crushed vertebrae

FIG 2—Case XV Demineralization of head of right femur Note the heart shaped pelvis

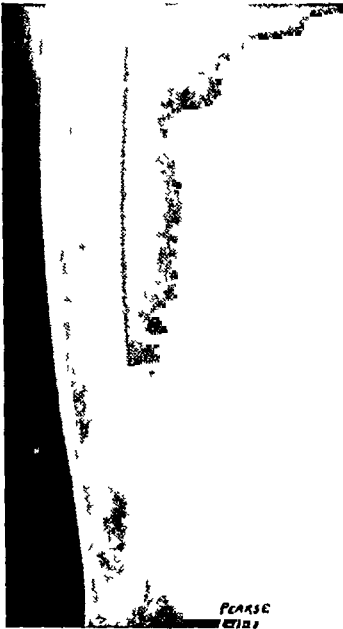


FIG 3—Case XV Demineralized and curving femur

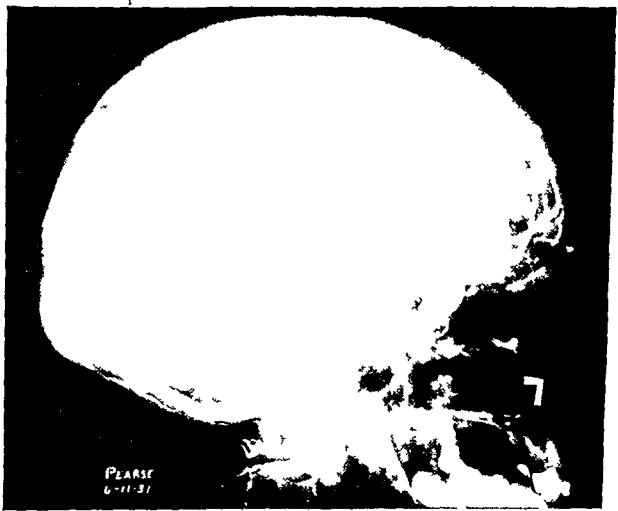


FIG 4—Case XV Skull beginning Paget type

sidered in connection with this affection. Supporting Bouguignon's publication, we have had under observation for several years a tumor of the maxilla which had been removed elsewhere with a diagnosis of sarcoma of the jaw (just as legs have been amputated for giant-cell tumor of this type). The patient is a woman who looks exactly like Hamburger's patient with



FIG 5—Case F T ♂ aged sixty. Recent operated case with findings resembling Paget's disease and osteitis fibrosa. Note marked kyphosis, enlarged skull (head size changed from  $6\frac{3}{8}$  to  $8\frac{3}{8}$ ).

FIG 6—Case F T. Note drawing in of head between shoulders and approach of costal arch to pelvis. Left tibia Paget type.

leontiasis ossea. Three or four years after her jaw resection, the process not only extended further into the jaw, but, when one day her complaints of backache led us to take more Roentgen-rays, a diffuse osteitis fibrosa cystica of the spine, pelvis, femora, etc., was found. Illustrating the endocrine

surgical derelicts as they are called. Logic should prevent this from happening again in parathyroidism.

Of the twenty to thirty cases of parathyroidism published so far practically all were extremely decalcified, had several fractures, were bent over and had ankylotic spines. To be sure most of this damage cannot be repaired. The operation in these far-progressed cases, with the chin approaching the chest, is technically difficult. With the exception of Pemberton's case and two or three of our own, the disease was very far advanced before operation was resorted to. In spite of this, in far-advanced cases of Quick and Hunsburger, of Snapper, and in a case seen by us with Dr Grover Penberthy, and our own cases I, II, III, XVI, improvement was immediate as far as relief of pain is concerned, and encouraging in the improve-

ment of function and the return of calcium into the bones. We could logically expect more if the early cases are operated upon. The diagnosis should be made early on the symptoms of pain, beginning demineralization and beginning compression of vertebræ, or on beginning bone cysts, before the whole sad picture is established. If we look for these early symptoms the number of patients found to be suffering from parathyroidism will be very large. The skeletal symptoms are likely often covered up in the patient's complaints by intestinal upsets (de Pemberton), muscular weakness, burning sensation in skin (as known also to be caused by the sudden hypercalcæmia after intravenous injection of calcium chloride).



FIG 9.—Mrs I McG. Early case in young woman twenty six years old showing ankylotic kyphosis. Blood calcium 12.14 milligrams and X-ray findings of wedging of upper dorsal vertebræ and hypertrophic arthritis. Parathyroidectomy gave relief of pain.

so void of danger that early operation is justified. Late operation is obviously indicated, because these people suffer so much pain and are so crippled that life is not worth living. Take the second question first—the danger of the operation. In the cases reported in the literature, including our own, only the case of Beck was followed by fatal tetany. The two fatal cases of Toland three months after operation obviously do not belong to this group. They were cancers or malignancies of the parathyroid, and had no bone complications whatever. Severe post-operative tetany followed

Here two points should be prominent in our minds. First, how is this picture to be recognized early, and second, if recognized, is the operation



FIG 10.—An early case of Oppel's type Blood calcium 14 milligrams Pain severe The arrows in disc wedging with a diminution of intervertebral discs and calcification of the anterior vertebral ligament



FIG 11.—Symptoms as in FIG 10 less pronounced Drignosed early, but shows wedging and overgrowth



FIG 12.—Mrs S Long standing senile type

roidism—December, 1930, Wm H Gordon Operation—December, 1930, two lower parathyroid bodies removed from thyroid Microscopy—Two parathyroids with cyst formation Marked fibrosis Post-operative course—Good Final recovery—Fine Gained 20 pounds in six months No pain Discarded crutches Ca stayed 11 for three months

CASE IV—R M (Type IV), female, fifty-seven years Onset of disease—1927, short spell of backache October, 1930, more severe, sleepless First symptoms—Spondyloarthritis Progress—Kyphosis Becoming shorter X-ray findings—Deminerization of vertebræ and radius with reduction of height of bodies Blood Ca—14.6, 11.6, 9.2 G I Symptoms—Frequent vomiting Diagnosed parathyroidism—R C Moehlig Operation—February 9, 1931, adenoma of thyroid Bilateral subtotal lobectomy Two lower parathyroids Microscopy—Adenomatous parathyroids, fat spaces, no acidophile cells Post-operative course—Hæmorrhage of left inferior thyroid, required packing and tracheotomy Finally O K Final recovery—Splendid Pain gone May, 1931, Ca 10 June, 1931, Ca 11.6 No X-ray check so far

CASE V—J M (colored) (Types II and III), female, thirty years Onset of disease—Started at age of thirteen Fractured left leg below hip 1926, Myomectomy after this Symptoms—Leg became painful, also left elbow First diagnosis—Bone cysts of femur with fracture Progress—Crutches and much of time in bed X-ray findings—Cyst-like process left, ilium and left acetabulum, head neck and upper third of left femur Less in right ilium Osteitis fibrosa cystica left elbow Slight old fracture external condyle (not known to patient) Blood Ca—11 Diagnosed parathyroidism—A R Bloom Operation—February 3, 1931, bilateral subtotal thyroid lobectomy Two inferior parathyroids Microscopy—Two parathyroids Adenomatous Hæmorrhage Large fat islands Post-operative course—Good Final recovery—Fine Walks without crutches or splint No more pain May, 1931, large cyst process in femur and os ilium less in size Beginning calcification

CASE VI—H G (Types I and IV), female, forty-seven years Onset of disease—1916, pelvic inflammatory disease, salpingectomy 1921, hysterectomy Symptoms—1930, backache, pain in liver region, vomiting First diagnosis—Gastric ulcer with cholecystitis Progress—High kyphosis X-ray findings—Lateral and posterior curvature of dorsal spine Calcification of intervertebral discs Wedging of vertebræ Erosion of spinal joint Blood Ca—11.2, 11.2 Urine—0 G I Symptoms—Gastric disturbance ten years Much treatment Developed argyria Metastatic calcifications—Marked calcification of costal cartilages Diagnosed parathyroidism—R C Moehlig Operation—April 23, 1931 Bilateral lobectomy of adenomatous thyroid Two parathyroids Microscopy—Biological test—Parathyroids transplanted in case of tetany with cessation of tetany Post-operative course—Smooth Final recovery—Fine No pain No gastric symptoms for two months since operation June, Ca 11.2

CASE VII—A M R (Type IV), male, fifty-three years Onset of disease—January 19, 1929 Operated for toxic adenomatous goitre Symptoms—Paralysis agitans First diagnosis—Paralysis agitans, arthritis Progress—Later developed Parkinson's syndrome X-ray findings—Spondylo-arthritis Blood Ca—10, 9, 8 Urine—0 G I Symptoms—0 Diagnosed parathyroidism—R C Moehlig Operation—May 12, 1931 Parathyroidectomy Two small parathyroids removed Microscopy—Adenomatous, cystic changes Post-operative course—Smooth Final recovery—No progress of symptoms

CASE VIII—McA (Type IV), female, twenty-six Onset of disease—1929, after pregnancy, painful curved back Symptoms—Stiffness and pain in back High dorsal kyphosis Resisting good orthopedic care First diagnosis—Infectious arthritis Progress—Severe painful joints, causing insomnia X-ray findings—Marked dorsal kyphosis, intervertebral spaces diminished, so that anterior processes of segments approach each other Diminished width and narrowing of three vertebræ Blood Ca—10.4, 11 Urine—Pyelitis Dysuria at times Diagnosed parathyroidism—R V Funston Operation—



ankylosing arthritis of elbows, interphalangeal and knees Blood Ca—10, 11 Urine—0 G I Symptoms—0 Diagnosed parathyroidism—R V Funston Operation—June 6, 1931, bilateral thyroid lobectomy for adenomatous goitre Two bodies removed as parathyroids Microscopy—Bodies removed as parathyroids proved to be lymph glands Still had mild post-operative tetany Post-operative course—Smooth Final recovery—Case not useful for statistics No parathyroid removed

CASE XV—G P (Type II), female, fifty-two years Onset of disease—Five years ago with rheumatism Symptoms—Several rib fractures two years ago Severe pain in hip and right groin five months ago First diagnosis—Osteo-malacia, coxa vara Progress—Limping Marked scoliosis of upper spine Ribs approached pelvis Height shortened two inches Spine partially ankylosed X-ray findings Extensive demineralization of all bones Wedging of vertebræ along lower dorsal segments and fifth lumbar, general skeletal demineralization, suggestion of Paget's disease of skull Blood Ca—12.8, 11, 14 Urine—0 G I Symptoms—0 Operation—June 13, 1931, thyroparathyroidectomy for adenomatous thyroid, two parathyroid bodies removed Microscopy—No acidophilia Diffuse fatty type Post-operative course—Tracheotomy performed for relief of dyspnoea Wound healed No inflammation Final recovery—Startling immediate recovery from arthritic pain

CASE XVI—A S (Type I and IV), female, fifty-three years Onset of disease—1925, hysterectomy for fibroid Symptoms—High back pain five months Interphalangeal arthritis acroparathesia First diagnosis—Spondyloarthritis Progress—Kyphosis, X-ray findings—Overgrowth of spinal articulation Diminished vertebral disks Wedging of dorsal segments Blood Ca—12, 14.8 Urine—0 G I Symptoms—0 Operation—June 17, 1931, large left bilateral subtotal thyroid lobectomy for adenomatous goitre Large left parathyroid—adenomatous Left smaller Microscopy—Not finished at the time of this report Post-operative course—Smooth Final recovery—No untoward results following operation Observation period short

*Pathology*—The judgment of the condition of parathyroidism seems to depend entirely upon the clinical symptoms correlated with the Roentgen-ray findings and the blood-calcium level There is very little in the histological examination of the glands to give a clue to their hyper-functioning state In fact, comparison of the parathyroids taken from normal cases, or from cases suffering from other diseases, with those of the operative cases of parathyroidism, shows differences so small as to be unimportant in diagnosis One or two findings have been noted that may be significant First the tendency to diffuse and focal round-cell infiltration of the gland, which is certainly an abnormal condition and which is reminiscent of the round-cell infiltration so common in thyroid adenomata Cystic areas filled with a very thin, pale, blue-staining colloid are noted, but they have also been noted in supposedly normal organs, and were described by Sandstrom in his original description of the anatomy of the epithelial bodies They have been considered by others to represent degenerative changes and may have some significance in this regard just as the degenerative changes in thyroid adenomata are considered to be evidences of anatomic breaking-down from functional over-strain

From a general survey of the parathyroid tissue so far removed by us, we would say that compact nodules forming in the peri-glandular fat, and even isolated nodules found in fat tissue not directly connected with parathyroid bodies are possibly more significant as indicating a hyper-functioning state than any of the other changes A great deal of significance should be

This shell-out method—considered from the standpoint of carcinoma—is the type of operation that they had been doing, particularly since a work on parathyroids that was done in his (*Terry*) clinic, the occurrence of parathyroids on the anterior portion of the thyroid. It is surprising—in 10 per cent of the cadavers one or more of the parathyroids is on the anterior portion. Doctor Tinker, by his technic, saves those, and the speaker was sure that he does the same operation for the non-malignant as for the malignant.

Doctor Terry started in with the electro knife some years ago, but he did not have the persistence of Doctor Tinker. The machine was not a particularly good one, they did not have the right changes in the electric current, they did not have anybody that understood it thoroughly enough to make the proper changes in the current so that one could get the coagulation or cutting effect. But since Doctor Tinker's paper on a similar subject came out some time ago Doctor Searles began using it for the coagulation of the vessels outside the muscles under the skin flap, although he hasn't as yet used it in the gland itself.

The speaker did that in one case recently with quite a degree of satisfaction. It did away with the ligatures necessary externally and shortened the time of operation. But with Doctor Tinker's experience, and his advice, he will try the knife on the gland itself, because he felt that his bad results have been due to bad currents and poor technic on their part.

DR HARRY H. KERR (Washington, D. C.) discussed Doctor Naffziger's paper on persisting and progressive exophthalmos. He said that no one has proved why exophthalmos occurs in exophthalmic goitre, nor has anyone proved what produces it. Further than that, the progressive type that continues even after thyroidectomy has never been adequately explained. This case shows a very striking result, and we believe we now have some actual data that will perhaps solve this very interesting problem.

Doctor Naffziger's experience is also fascinating in the speculation that it stimulates as to other factors in the question of involvement of the optic nerve. There has never been a complete and satisfactory exposition of choked disc. One usually accepts the theory that increased intra-cranial pressure affects the optic disc by the pressure of the cerebrospinal fluid around the nerve in the dural envelope. This pressure is transmitted to the central vein of the retina with resultant oedema and choking of the disc. There has never been a complete explanation of choked disc in other conditions without increased intra-cranial pressure. Nor does this theory explain why there is no choking of the disc in cases where there is a definite increase in venous pressure without an increase of the intra-cranial pressure. The first is illustrated by the presence of choked disc in cases of sinus disease, without increased intra-cranial pressure. The second is illustrated by the absence of choked disc in pulsating exophthalmos. In these cases where there is an arterial fistula between the internal carotid artery and the cavernous sinus, the venous pressure is at its highest, and still a choked disc does not occur.

The decompression of the optic nerve and muscles in this case not only cured a persistent and progressive exophthalmos, but has also cured a choked disc. He believed it is a very profound contribution that promises to be of great value in future research.

DR LEONARD FREEMAN (Denver, Colorado) discussing the paper by Doctor Ballin on parathyroidectomy called attention to the work of Leriche, of Strasbourg, who has reported, in the French, that he has deliberately removed the parathyroid for scleroderma, a skin disease, basing the operation upon the researches of Poltier. He seemed to demonstrate that scleroderma nearly always expressed—or sometimes expressed—a hypercalcemia. He removed the parathyroid upon the right side, the lower parathyroid. The result was startling. Within a few days the pathologic condition of the skin subsided, the symptoms all disappeared, as well as the pain. The case was followed up for some length of time, and it seemed to be more or less permanent. He also reports a second case of a similar character.

DR RICHARD H. MILLER (Boston, Massachusetts) said that he had operated upon

## RESECTION OF THE CÆCUM

By FREDERIC N G STARR, M B , C B E

OF TORONTO, CANADA

LOOKING back over some forty-five years, one cannot help but be impressed with the strides that have been made in gastro-intestinal surgery during that period. It was only a few years before that time that a surgeon was brave enough to attempt reparative or even relief, operations upon the gastro-intestinal tract. In fact, in those earlier years abdominal surgery was confined largely to the removal of large tumors of the uterus, and of large ovarian cysts. Rarely was any operation done upon the intestines, except for large bowel obstruction, which consisted mostly of colostomy, and this was done through the loin.

It is true that in 1837, Egebert, a Norwegian military surgeon, read a paper on gastrostomy at the Christiana Medical Society.

It is reported by Marshall that Reybard, of Lyons, performed the first resection of the colon in 1844, but the paper was rejected for publication "because of some want of definiteness."

In 1878 Baum, of Dantzic, removed a growth from the ascending colon, but fæces escaped and the patient died on the seventh day.

In 1878 Martin, of Hamburg, successfully removed the sigmoid.

Of course every little while resections of gangrenous bowel in hernias were done with varying success. Then as technic improved, intestinal surgery advanced by leaps and bounds. The Mayo-Robson bobbin, the Senn decalcified bone-plates, and the ingenious button devised by John B. Murphy, all assisted in showing the way to make these more safe.

In my earlier resections I resorted to the Murphy button until one ulcerated into the peritoneal cavity. Then I turned to the lateral anastomosis. These were most satisfactory and gave very little anxiety during their convalescence. In the meantime the roentgen ray was discovered and some of these patients began to drift back complaining of indefinite discomfort, upon examination sometimes one could discover a mass. Upon X-ray examination it was found that a large pocket had formed at the blind ends of the bowel, in which fæces accumulated.

I then decided to resort to the end-to-end anastomosis, but there was trouble in about one in four of these because of the œdema that took place at the line of suture, giving rise to a temporary obstruction, and a fæcal fistula would form before the œdema could subside. In 1920 I began to use a piece of rubber tube incorporated at the site of the anastomosis,<sup>5</sup> which maintains a lumen through the anastomosis until the œdema subsides. Since this there have been no fæcal fistulæ, and the convalescence has been comfortable and satisfactory with no untoward signs of obstruction.

# SURGICAL TREATMENT OF TUBERCULOMA OF THE CÆCUM

BY HARRY HYLAND KERR, M D

OF WASHINGTON, D C

TUBERCULOSIS usually affects the intestinal canal as an ulcerative enteritis. In this form it accompanies general tuberculosis, and is found in about 50 per cent of autopsies of cases dying from tuberculosis.

The intestinal canal is occasionally infected by the tubercle bacillus without invading any other tissues of the body. Such isolated infections produce the neoplastic type of intestinal tuberculosis known as hyperplastic ileocæcal tuberculosis or tuberculoma of the cæcum.

Tuberculoma of the cæcum is most commonly found in young adults. The youngest of my five cases was fifteen, the oldest twenty-eight.

In the early stages it is usually diagnosed as appendicitis. Later, when the tumor formation has occurred or obstruction supervened, it is often mistaken for cancer. The X-ray examination is characteristic. There is a filling defect of the cæcum at the site of a mildly tender mass.

As the disease progresses it tends to interfere with bowel function, and acute obstruction may occur.

The treatment is surgical. Good results have been reported after heliotherapy. In one of my cases a clinical cure resulted after two years of sanitarium treatment. In another, there was little response to light therapy in a year and surgery had to be resorted to because of acute obstruction.

As bowel function is impaired by the lesion, overfeeding—that sheet anchor of tuberculosis—therapy is impossible.

If the tuberculoma can be removed without undue risk and the function of the intestinal canal restored, surgery would seem to be the quickest, most radical, and most economical treatment.

Resection of the tuberculoma by the basting-stitch technic should carry little or no mortality and should result in complete cure. I have seen five cases of tuberculoma of the cæcum, four of which have had their lesions radically removed by the basting-stitch technic without mortality and with complete relief.

The author then presented a moving picture which illustrated a resection of the cæcum and ascending colon for tuberculoma performed six weeks after an ileocolostomy had been established for acute obstruction.

The picture, taken by Dr Daniel L. Borden at the Garfield Memorial Hospital of Washington, D C, presented the following:

The tuberculoma of the cæcum is mobilized and lifted from the posterior abdominal wall with its mesentery and glands.

The dilated ileum and relatively collapsed transverse colon are apposed and the sites are selected for resection.

# DIVERTICULITIS OF THE COLON

A REPORT OF 36 CASES FROM THE NEW YORK HOSPITAL  
BY FRANCIS M. CONWAY, M.D., AND JAMES M. HITZROT, M.D.  
OF NEW YORK, N. Y.

FROM THE FIRST SURGICAL (CORNFELL) DIVISION OF THE NEW YORK HOSPITAL

IN A discussion of the subject of diverticulitis of the colon, it has been customary to define exactly what one means by the term "diverticulitis." Many have taken care, and correctly so, to distinguish the congenital or true type of diverticulum, as represented by the Meckel's type of diverticulum, from the false or acquired type of gut-pocketing which is the result of a mucosal herniation through the coats of the gut wall. It has impressed the authors that in many of the reviews of the subject, the relationship of "diverticulitis" to the antecedent and practically symptomless "diverticulosis" of the colon has not received enough stress, and that the generalized character of the disease has not been completely emphasized. The observation that there exists in certain individuals, and in the major portion of these types during a certain decade of their life cycle, this tendency to mucosal herniation of the intestinal wall is rather significant. By the generalized character of the disease is meant that although one may find only a diverticulitis in the sigmoid colon, there is usually an associated and accompanying diverticulosis in other regions. Before defining the term, an elaboration of the etiologic factors underlying the condition is advisable for a more comprehensive understanding of it.

*Etiology*—The actual method of origin of these gut out-pocketings is not understood, although many explanations have been advanced for their presence. They are not congenital in character, as they have been seen to develop through all stages and at a more or less constant time in life, *i.e.*, in the fourth to the sixth decade. Certain factors are offered as being of some significance.

*Age*—The age at which these gut-pocketings are seen is most commonly between the ages of forty and sixty. Telling,<sup>11</sup> in his series of sixty cases found the average age to be sixty, while in our series of thirty-six cases, the average age was fifty years. The youngest case in our series was found in an individual of thirty and the oldest in a patient of sixty-seven.

*Sex*—In most series, the incidence is taken to be two to one for males as compared with females. However, Newton,<sup>10</sup> in his report of forty cases found it to be almost one to one, and in our listing of thirty-six cases, there were eighteen males and eighteen females.

*Obesity*—Most of the cases seen were usually in well-nourished persons who were slightly overweight.

*Constipation*—Constipation and flatulence have long been held as prime

on diseases of the alimentary canal reported a series of cases with some pathologic findings including some of the complications of the condition Klebs<sup>26</sup> in 1869 was among the first to recognize the origin of the condition in the diverticula

Grossly, the pouches look like pea-shaped projections from the bowel. These may be contained in the appendices epiploicæ or are covered with fat and are not visible. Inasmuch as they frequently tend to grow into the appendices epiploicæ, they are most difficult to distinguish *in situ* and all that one sees is a tuberous-like appearance of the bowel. When however the fat is stripped off, the diverticula are seen as typically bottle-shaped out-pocketings, dark blue in color. The characteristic dark blue color is due to the fact that the mucosa and submucosa have herniated through the muscle wall and the contained fecoliths are seen through this wall. Usually a thin



FIG 1



FIG 2

FIG 1—Pathologic specimen No 21470. Section shows a typical herniation of the mucosa through the muscularis and the formation of a diverticulum. Section in addition shows a portion of the mucosa with evidences of a catarrhal inflammation, round cell infiltration of the submucosa, muscularis and adjacent fat tissue. Specimen removed at operation from Case XXXI. Chronic perforative diverticulitis of the descending colon with abscess.

FIG 2—Pathologic specimen No 19727. Section represents diverticulum wall showing it to be lined with granulation tissue that is infiltrated with numerous plasma round cells, eosinophiles and many polynuclear leucocytes. The submucosa shows similar inflammatory changes. Specimen removed at operation from Case XXX. Chronic diverticulitis with pericolicitis and stenosis.

strip, whitish in color, can be made out about the neck of the diverticulum, marking the limit of the muscle covering.

Microscopically there is a rarefying of the bowel muscle in the diverticular areas and in many sections (*viz* Fig 1) the mucosa and submucosa may be seen penetrating the coats of the intestinal wall. Following the development of the pericolicitis, as the process continues, abscesses and fistulæ are formed. The sites of spread are commonly to the bladder, small intestines, and abdominal wall in the male while in the female, in addition to these, the adnexæ and uterus are frequently involved. As the chronic inflammation continues, it leads to a fibrous thickening of the gut wall with resultant stenosis of the bowel with a wall from one-half to one inch in thickness. Accordingly, it may be seen that the attack of diverticulitis with threatened obstruction may occur as the result of two conditions which differ widely

picture is fairly characteristic. In the early stages, before stenosis has completely distorted the appearance, there are spiked or palisade-like projections of the barium shadows from the lumen of the bowel, the wall of which is thickened from the inflammatory exudate and fixed. This appearance is caused by the deformity and contracture of the haustra. The other picture with the bleb-like deposits of the barium in the actual diverticula is well known. As regards the location of the diverticula, although they are found throughout the colon, the commonest site is in the sigmoid. The following table shows the distribution in various series.

Series	Sigmoid	Sigmoid and Pelvic	Descend Colon	Descend and Sigmoid	Trans verse	Ascend Colon	Entire Colon	Appendix	Cecum	Rectum
Newton 44 cases	25		12			1	8		1	
Spriggs and Marver 166 cases		120	79		33	33	24	6	8	4
New York Hospital 36 cases	17		3	10	1	2	1		1	
Lockhardt Mummery 41 cases	36				3	1			1	

*Classification*—An attempt has been made to group the cases in this series after a schema used by Monsarrat which seemed to be as lucid and complete as any encountered. They are as follows:

(1) Acute diverticulitis without perforation or complication. (2) Chronic diverticulitis without perforation or complication. (3) Acute perforative diverticulitis with peritonitis. (4) Chronic perforative diverticulitis with complication such as abscess or fistula formation. It is to be realized that there is no sharp differential diagnosis existent between groups 3 and 4. Group 4 forms the largest group and within it are those cases of "pericolicitis sinistra" and cases where no single perforation was demonstrable. (5) Diverticulitis with stenosis. (6) Diverticulitis with coincident carcinoma.

In Group 1 have been placed those cases where there is an inflammation of the mucosal folds with an inflammation of one or more diverticula followed by subsidence of the attack without any complication. In Group 2 have been placed those cases where there has been a vague history of flatulence, constipation, and where radiographic plates or subsequent laparotomy have revealed the presence of diverticula but without any complicating condition.

In Group 3 have been placed those cases of perforative diverticulitis with peritonitis where the first symptom of the condition was, in many cases, the symptomatology following their generalized peritonitis. This group merges gradually into the next class Group 4.

In Group 4 have been placed those cases with complicating factors such as abscess, secondary involvement of other viscera, and fistula formation.

were treated conservatively with the exception of one case Case XXXII which was discharged from the hospital as unimproved

The non-surgical treatment which is the same for an early case of diverticulitis as that of diverticulosis, consists in keeping the body, the alimentary canal, and especially the mouth and colon as healthy and clean as possible. Any source of sepsis that can be reached must be removed (Spriggs). The diet should be simple and regular, with a good deal of fruit and vegetables and little meat. Meat may be given two or three times a week to begin with but later added daily, if desired, providing that regular bowel movements are established. If there is such a degree of inflammation of the mucous membrane as to make it undesirable to give fruit greens or whole wheat bread an entirely non-irritating or bland diet of cereals, milk or fish is needed. Altering the intestinal flora by vegetable foods and *Bacillus Acidophilus* in milk also seems to do some good. In addition, milk sugar is given as a pabulum for the *B. Acidophilus*. The use of mineral oil in amounts sufficient to insure the soft character of the bowel movements is of utmost importance.

With Types III and IV the question of therapy is determined by the individual case, as may be seen by the various procedures performed on the cases placed in these groups. It is in this sub-division that the question of treatment is distinctly surgical in character.

With Type V, the question of resection in the presence of sub-acute obstruction is another point of dispute, as some are of the opinion that resection should be prefaced by a long trial of medical therapy, and that if the bowel is becoming more and more constricted, preliminary cæcostomy or colostomy above the point of stenosis should be considered.

#### CONCLUSIONS

1 Diverticulitis of the colon, by virtue of its intrinsic pathology will produce a variety of symptoms.

2 Although the majority of the cases show involvement of the sigmoid, the condition is not limited to that region.

3 The actual method of production of these mucosal herniations is unknown, although two methods of possible formation are considered.

4 Diverticulosis of the colon, being a precursor of the condition, is not to be regarded lightly, and vague gastrointestinal upsets and attacks of flatulence in adults between the ages of forty and sixty warrant further investigation, which should include a barium series.

5 Diverticulitis is the final stage of diverticulosis where the small pouches become involved and destroyed in the chronic inflammatory process, which in the first place arose in themselves.

6 In this series, the symptoms in order of their frequency were Pain across the lower abdomen usually more pronounced in the left lower quadrant, constipation, flatulence, nausea, palpable tumor mass, diarrhoea, melæna and urinary urgency.



# CONWAY AND HITZROT

TABLE I—(Continued)

- (4) Sigmoid, 2 days Biopsy and Miculicz' tampon drain (No 13) Died (general peritonitis)
- (5) Sigmoid, 1 month Miculicz' operation (first stage) (No 4) Died (general peritonitis)
- (6) Cæcum, ascending and right transverse, 5 days Resection of ascending colon and hepatic flexure (hemicolectomy) (No 11) Died (pneumonia)
- (7) Cæcum, 2 days Suture of perforation without drainage (No 3) Died (general peritonitis)
- (8) Cæcum, 2 days Excision of diverticula without drainage (No 2) Improved
- (9) Sigmoid, 2 to 3 weeks Miculicz' operation (first, second and third stages) (No 1) Improved

## *Group "D"—Chronic Perforative Diverticulitis with Abscess (Fourteen Cases)*

- (1) Sigmoid, 2 years Laparotomy, incision and drainage of abscess (No 33) Improved
- (2) Descending Excision of diverticulum with drainage (No 31) Improved
- (3) Sigmoid and descending, 10 days Laparotomy, biopsy (No 21) Improved
- (4) Sigmoid, 2 years (a) Incision and drainage of abscess (August, 1927) (b) Excision of fistulous tract with drainage of abscess site (June, 1928) (c) Closure of fecal fistula (June, 1928) (No 20) Died (bronchopneumonia)
- (5) Sigmoid, 3 days Incision and drainage of abscess, Miculicz' tampon drain to site (No 17) Improved
- (6) Sigmoid, 1 day Resection of sigmoid with an end-to-end anastomosis (No 16) Improved
- (7) Descending and sigmoid, 5 days Excision of diverticulum (No 15) Improved
- (8) Ascending colon, 5 weeks Miculicz' operation (first, second and third stages) (No 14) Improved
- (9) Descending, 2 weeks Incision and drainage (No 9) Improved
- (10) Sigmoid, 3 months Miculicz' operation (first, second and third stages), left salpingo-oophorectomy (No 8) Improved
- (11) Sigmoid, 6 months Partial resection with drainage (No 7) Improved
- (12) Sigmoid, 3 months Incision and drainage, Miculicz' tampon drain (No 6) Improved
- (13) Sigmoid, 2 to 3 months Miculicz' operation (first, second and third stages) (No 5) Improved
- (14) Sigmoid, 2 weeks Miculicz' operation (first, second and third stages) (No 36) Improved

## *Group 'E'—Diverticulitis with Stenosis (Two Cases)*

- (1) Sigmoid, 2½ years Resection of sigmoid with drainage (No 30) Improved
- (2) Descending and sigmoid, 3 weeks Conservative, dietary (No 12) Improved

## CASE RECORDS

CASE I—A M, male, fifty-one years of age, was admitted to the hospital for the first time February 21, 1930, with the complaint of dull dragging pain in the lower left quadrant, in the region of the sigmoid, of some two to three weeks' duration. The pain had remained localized to that area and did not radiate, but was accompanied by some nausea. He had not vomited, nor did he relate the pain in any way to the ingestion of

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\* There is no sharp differential diagnosis existent between Groups C and D. Group D forms the largest group, and within it are those cases of "pericolitis sinistra" and cases where no single perforation was demonstrable.

His post-operative course was entirely uneventful and he was allowed home on his ninth post-operative day with his wound healed by primary union, and general condition excellent Discharged February 4, 1928

The pathologic report of the specimen taken at operation was diverticulitis of the cæcum with evidence of acute inflammatory reaction in the surrounding fat tissue (Path No 37,118)

He was seen at the follow-up clinic May 4, 1928, three months after his discharge from the hospital, and his condition was reported as being satisfactory, although at times he was said to have an occasional pain in the right side

He was grouped in Group C—a case of acute perforative diverticulitis with peridiverticulitis

CASE III—G F, male, thirty-two years of age, was admitted to the hospital August 9, 1930, with a two-day history of pain in the right lower quadrant of the abdomen, localized to that area and not radiating Two days before entering hospital, he was suddenly stricken with a sharp knife-like pain on arising in the morning The pain continued, always remaining localized He did not vomit, nor did he feel nauseated No history of constipation or diarrhœa No melæna Had never had any previous attacks He was a well-nourished and well-developed man, appearing acutely ill, with pain, tenderness and rigidity in the right lower quadrant There was no palpable mass present Rectal examination disclosed very definite tenderness in the right rectal wall There was generalized tenderness all across the entire lower abdomen Temperature on admission, 101, pulse, 90, white blood-cells, 12,300, polymorphonuclears, 77 per cent, hæmoglobin, 90 per cent, urinalysis, negative

A pre-operative diagnosis of acute appendicitis was made and a laparotomy was performed At operation on opening the peritoneal cavity there was some escape of free fluid and evidence of a mild beginning peritonitis The appendix was delivered and found not to be acutely inflamed Appendectomy was performed Just distal to the ileocecal valve there was a diverticulum which was perforating and which had been sealed around by a small amount of inflammatory tissue The diverticulum was closed by a Z-stitch, and a tab of omentum fastened over it The abdomen was closed without drainage

His post-operative course was stormy and one of progressive decline On the morning of his first post-operative day, his temperature was 103, pulse, 114, and respiration, 20, and he was somewhat cyanosed He seemed to be suffering from a grave toxæmia In spite of all supportive measures, he expired on the second day after operation Culture of the fluid taken at time of operation was reported as being *B proteus*

*Necropsy findings were*—Diverticulum of cæcum, perforating with an associated acute generalized peritonitis Microscopic sections were reported as showing an acute hemorrhagic inflammatory reaction in the wall of the gut (Path No 42,141)

Case placed in Group C—acute perforative diverticulitis with an accompanying generalized peritonitis

CASE IV—J M, male, forty-five years of age, was admitted to the hospital October 18, 1930, with the history of cramp-like pain of two days' duration over the entire lower abdomen He stated that for one month prior to his entrance to the hospital he had been more or less constipated Purgatives seemed to relieve him only temporarily With the onset of the cramp-like pain, his bowels did not move at all, though he could still pass some gas and did pass both blood and mucus Has never had any previous attacks or gastro-intestinal upsets of any kind Past history negative except for hæmorrhoidectomy performed in 1928 He was acutely ill, with pain and tenderness all across the lower abdomen but with no palpable masses or rigidity Rectal examination disclosed definite tenderness in the left rectal wall Examination, except for the above and the presence of a bilateral bronchitis, was negative

complaining of pain in the left lower quadrant of his abdomen of five days duration and constipation for the same length of time. Cathartics did not seem to relieve the dull ache. He was put to bed and given a colonic irrigation with subsequent relief. A barium enema taken at that time revealed no evidence of obstruction but the colon showed bud-like shadows indicating a condition of diverticulosis. Twenty-four hours later remnants of the barium were seen in these small out-pocketings. He was seen at the follow-up clinic on June 14, 1930, and was reported as being perfectly well. Pathologic diagnosis (Path No 27,988) reported specimen obtained as showing pericolicitis, chronic mesenteritis, acute inflammatory reaction in the surrounding fat tissue.

This case was grouped in Group D—chronic perforative diverticulitis with abscess.

CASE VI—N L, female, fifty-three years of age, was admitted to hospital August 24, 1918, with the complaint of a dull pain that remained localized to the left lower quadrant of abdomen, of three months' duration. She has been constipated more or less for the same length of time and states that the taking of cathartics relieves the discomfort. For the month preceding her admission, the pain was increasing in severity. There was some slight tenderness in the left lower quadrant and the presence of a definitely palpable mass in that area.

*Laparotomy Performed*—In the left iliac fossa, there was found a mass walled off by many loops of adherent small intestine. On separating some of the loops of gut an abscess was disclosed. A Miculicz' tampon drain was inserted down to the abscess cavity. Her post-operative course was entirely satisfactory though somewhat prolonged. Culture of the pus obtained at time of operation was reported as showing a Gram-negative bacillus and a streptococcus. She was discharged from the hospital October 15, 1918 (fifty-third day after operation).

This case was placed in Group D—chronic perforative diverticulitis with perforation and abscess formation.

CASE VII—M C, female, forty-eight years of age, was admitted to the hospital June 22, 1920, with history of intermittent attacks of pain in the left lower quadrant of the abdomen of six months' duration. She stated that for the preceding six months she had had dull pain across her lower abdomen but more especially in the left lower quadrant. The attacks of pain are in no wise related to her menses, ingestion of food, or to bowel movements, but are increasing in frequency and severity. She was obese, not appearing acutely or chronically ill. Examination was quite negative except for some tenderness below the umbilicus and to the left of the mid-line, where, in addition, there was the sensation of a palpable mass.

*Laparotomy Performed*—At operation there was found to be a large mass in the recto-sigmoid surrounded by a large abscess. The mass was too large to be delivered. A partial resection was performed and drains placed to the abscess cavity.

Pathologic report (Path No 23,748) was diverticulitis of the sigmoid with perforation. Grossly, along the course of the gut, a number of diverticula are found. One of these shows a perforation leading into a cavity with ragged hæmorrhagic walls. Microscopically, there is a catarrhal inflammation of the mucosa, a thickening of the musculature and an acute inflammation of the surrounding fat tissue.

Her post-operative course was uneventful but prolonged. She developed a fecal fistula at the site of drainage and was discharged from the hospital on August 24, 1920 with her wound draining. She was seen at the follow-up clinic December 23, 1920, and was reported as being fairly well.

This case was placed in Group D—chronic perforative diverticulitis with abscess.

CASE VIII—S P D, female, thirty-eight years of age, was admitted to the hospital March 15, 1917, with a history of pain and a mass in the left lower quadrant of the abdomen of three months' duration. Three months prior to her entrance, she gave birth to a child and two weeks later was stricken with a pain in the left lower quadrant which seemed to radiate around to the left side and back. Pain is not constant but is of sufficient severity to cause her to take to her bed. She has been constipated for the

pain in every two or three months and these would sometimes last for two days. The pain is not related to meals, menses or to bowel movements but is increased by any pressure on the right side. The pain has never been intense but has been more of a dragging sensation. There is also a history of flatulence. In the right lower quadrant of the abdomen there are definite pain, tenderness and rigidity. On palpating over McBurney's point, one gets the impression of a globular mass which is fairly movable and tender.

*Laparotomy Performed*—At operation there was a mass about the size of two fists involving the cæcum and the transverse colon. There seemed to be deposits in the meso. Under the diagnosis of a carcinoma, a resection of the ascending colon and the hepatic flexure was completed. During the dissection the gut was opened and was subsequently found to be a pocket from the perforation of the diverticula in the cæcum which were adherent to the hepatic flexure. Anastomosis was made by lateral anastomosis of the lower ileum to the transverse colon at its mid-portion. Operation performed was a hemicolectomy.

The post-operative course was complicated by a bronchopneumonia from which the

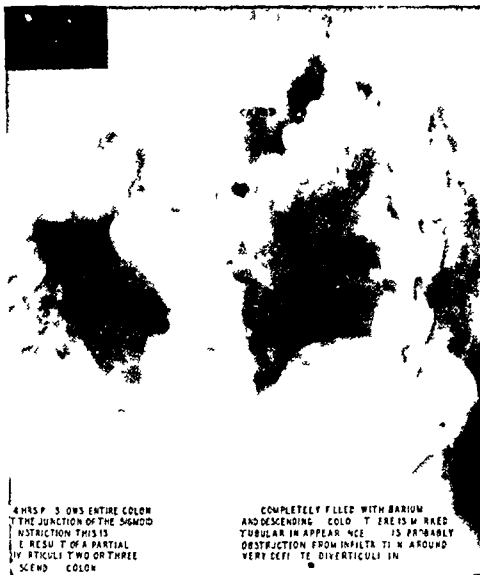


FIG 6

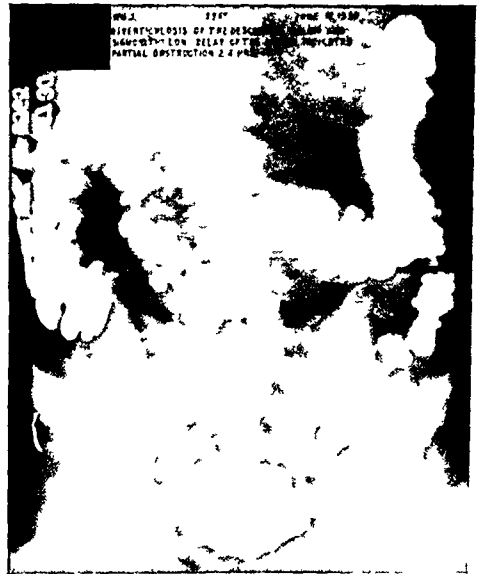


FIG 7

FIG 6—Radiographs from Case XII. Chronic diverticulitis with stenosis. Film No 8,658 taken September 14, 1929, shows a marked constriction at the junction of the descending and sigmoid colon. Constriction is tubular in appearance. There are definite diverticula seen in the descending colon. This patient was treated conservatively with bland dietary measures. Film No 8,596, taken one year later after the patient had been under observation for that interval September 29, 1930, shows no radiographic evidence of diverticula.

FIG 7—Radiograph from Case XXV. Acute diverticulitis without perforation or complication. Film No 5,565 taken June 18, 1930, shows the sigmoid and descending colon to be very spastic and with many bud-like shadows extending from the lumen of the bowel indicating an extensive diverticulitis. The long delay of the barium in the gastrointestinal series indicates some obstruction. Patient was treated conservatively on the medical division with subsequent diminution of symptoms and improvement.

patient died on the third day after operation. Pathologic report (Path No 41,128) was that of diverticulitis of the cæcum, perforating.

This case was placed in Group D—chronic diverticulitis, perforative with abscess.

CASE XII—L. C., female, sixty-four years of age, was admitted to hospital September 9, 1929, with the complaint of pain in the left lower quadrant of the abdomen accompanied by constipation for the three weeks preceding her entrance. Her history was essentially that of chronic constipation associated with lower abdominal pain and nausea of three weeks' duration. She was somewhat obese and had pain and tenderness in the left lower quadrant of the abdomen. At proctoscopic examination the proctoscope was

The entire ascending colon and half the transverse colon were freed and brought out of the wound. First-stage Miculicz' operation was done May 9, 1927, second-stage Miculicz' May 12, 1927, and third-stage Miculicz' was completed on his seventy-fourth post-operative day.

His post-operative course was stormy after the completion of the third-stage Miculicz operation when he developed a pulmonary complication. He was given two transfusions and allowed out of the hospital on the ninety-first day after operation, at which time there was a slight amount of drainage from the lower angle of his wound. He was seen in the follow-up clinic February 2, 1928, when it was reported that his wound was healed, firm and painless and that he had gained weight. He reported again May 16, 1929, and stated that he was working and his condition was declared to be very satisfactory.

This case was placed in Group D—chronic perforative diverticulitis with abscess.

CASE XV—A B, female, forty-three years of age, was admitted to the hospital March 23, 1928, with the complaint of pain in the left lower quadrant of three days duration. Five days prior to her entrance to the hospital she was stricken with a dull ache in the left lower quadrant of the abdomen and shortly thereafter noted the presence of a mass about the size of an orange in that region. Two days after the onset, pain became more severe and on the night before admission was intense enough to cause her to feel nauseated. She has not vomited nor has she been constipated. Past history negative except for an appendectomy and hysterectomy performed in 1920. She was well-nourished and did not appear especially ill, but had definite tenderness in the left lower quadrant, with some increase in muscle spasm.

*Laparotomy Performed*—At operation there was a gangrenous appendix epiploica of the upper sigmoid colon which was adherent to the abdominal wall and which created a little pocket into which several loops of small intestine were injected. These were easily dislodged and no damage to the circulation seen. The gangrenous appendix epiploica, which was a flat triangular structure about 1 by  $1\frac{1}{2}$  inches, was resected. Post-operative course was quite uneventful and she was allowed home on her fifteenth day after operation in good general condition.

Pathologic report (No 37,420) described the microscopic section as being that of sub-acute inflammatory reaction in fat tissue.

She was seen later at the follow-up clinic and her condition described as being excellent and with no complaints.

Case placed in Group D—chronic perforated diverticulitis with abscess.

CASE XVI—T M, male, sixty-one years of age, was admitted to the hospital December 26, 1925, with the complaint of cramp-like pain about the umbilicus of twenty-four hours' duration. On the day preceding, he was suddenly stricken with a sudden sharp pain about the umbilicus and felt nauseated, but did not vomit. He has always been constipated, but has never had an attack of pain like the present one. Past history is quite negative. He looked acutely ill and had definite pain and tenderness across the lower abdomen.

*Laparotomy Performed*—At operation the sigmoid was the site of a tumor which was inflamed and bound down. The mass was delivered with difficulty and about eight inches of the sigmoid with the mass was excised. An end-to-end anastomosis was performed. Appendectomy.

His post-operative course was complicated by the development of a fecal fistula on the fifth post-operative day. He was allowed home on the fifty-third day after operation with only a small granulating area present. He reported to the follow-up clinic May 8, 1926 where the notation was made that he had gained in weight, that his general condition seemed satisfactory and that there was only a slight serous ooze from his wound. He reported again December 9, 1927, when his condition was reported as being excellent and that he had returned to his work.

August 14, 1925, with the complaint of pain in the mid-hypogastrium of two days' duration. The pain at the onset was sharp and stabbing in character but remained localized and did not radiate. Shortly after the onset, he vomited twice. His bowels have been quite regular. He has had four similar attacks in the past two years. He appeared acutely ill and had definite tenderness and rigidity in the mid-line below the umbilicus.

*Laparotomy Performed*—On opening the abdomen some thin purulent fluid was found. A diverticulum of the sigmoid flexure was found markedly inflamed and with some fibrin on its peritoneal surface. The diverticulum was excised and a purse-string suture placed across the base. There was an area on the lower border of a loop of ileum near the mesentery which presented some fibrin, due most probably to contact with the perforated diverticulum. Cigarette drain placed to the site.

His post-operative course was uneventful except for a slight abscess of the wound which was evacuated on the fifth day after operation. He was allowed home on the sixteenth post-operative day (August 31, 1925) with his wound granulating nicely.

He was re-admitted to the hospital in November, 1929, with the story that, following his discharge in 1925, he had remained perfectly well for two years. At this time, 1927, he began to have vague epigastric distress associated with some pain. He has been constipated and has hemorrhoids which bleed. His physical examination was normal except for some slight pain in the mid-epigastrium.

An exploratory laparotomy was performed and many dense adhesions between the cecum and ileum and the ileum and sigmoid were found. These were freed throughout the length of the ileum.

His post-operative course was entirely satisfactory, he was allowed home November 27, 1929, his twelfth post-operative day, with his wound healed by primary union. He was seen again February 6, 1930, when his condition was reported as being satisfactory.

Group C—acute perforated diverticulitis

CASE XX—M. L., female, fifty-eight years of age, was admitted to the hospital May 23, 1928, with a draining colostomy wound in the left lower quadrant of her abdomen and with the history that for many years she had had attacks of "colitis" with frequent watery and sometimes blood-streaked stools. At the age of thirty she had had an exploratory laparotomy performed and that "nothing was found." Ten months ago (August, 1927) she had another attack and was admitted to St. Peter's Hospital in Brooklyn, N. Y. Communication from that institution states that at the time of her admission there she gave a history of generalized abdominal pain, attacks of vomiting and chills of eight days' duration. Laparotomy was performed and a diagnosis of diverticulitis of the sigmoid colon made. At operation, the diverticula were said to be encased in a fibrous mass, with the sigmoid pulled over and the omentum tied down to the mass. A colostomy was performed. She was discharged improved. Her wound has continued to drain and just prior to her admission to New York Hospital, amount has increased. She was a rather obese white female, not appearing acutely ill. Examination was quite negative except for draining sinus in left lower quadrant. At proctoscopic examination at a level of seven inches from the anal opening, the bowel appeared angulated, narrowed and the mucosa congested.

A barium enema did not fill the colon freely. The lower portion of the descending colon and the upper portion of the sigmoid were narrowed and spastic and diverticula were seen in this region.

*Laparotomy Performed*—Operation was excision of fistulous tract with drainage of abscess and partial closure of the fistulous tract. There were two abscess cavities, one of which was in the pelvis and the other surrounding the sigmoid. The sinus of the fistulous tract ran down to the fat around the sigmoid colon.

Six weeks later following the drainage of the abscess cavities, the sinus tract was completely excised, a cyst of the ovary removed and the fecal fistula closed.

Post-operative course was one of rapid decline and she expired twenty-five hours later. Post-mortem examination (Autopsy No 6,982) disclosed an acute perforative sigmoid diverticulitis with generalized peritonitis.

This case was placed in Group C—acute perforative diverticulitis with peritonitis.

CASE XXIII—C T, female, forty-two years of age, was admitted to the hospital January 29, 1930. This was her third admission to the hospital, her two previous admissions having been in May, 1914, when she was operated upon for chronic appendicitis. Following her operation her convalescence was quite uneventful. She now complains of pain in the left lower quadrant, of twelve months' duration. Pain is more or less constant and at times is quite sharp. For the month immediately preceding her admission, it had increased in frequency and intensity.

Radiographs of the colon report that the enema fills a rather redundant sigmoid and descending colon and the remainder of the colon normally and completely. High in the descending and in the left transverse colon are some bud-like shadows indicating diverticula. After evacuation the bowel is well emptied and the diverticula are more clearly seen. She left the hospital February 5, 1930.

This case was placed in Group B—chronic diverticulitis without perforation or complication.

CASE XXIV—P M, male, fifty-four years of age, was admitted to the hospital March 30, 1930, with the complaint of pain across the lower abdomen of fourteen hours duration, pain most intense in the left lower quadrant of the abdomen. He had had two similar attacks, one one year ago and the other about five months ago. He states that following the ingestion of a heavy meal which he ate hurriedly, he began to have cramps in the lower abdomen. He tried to move his bowels with but little success. On the morning of admission, the pain returned, and following the taking of a saline purge and a colonic irrigation, he vomited once. The pain increased in severity and he decided to come to the hospital for relief. He has lost no weight, has passed no blood in his stools and has had no genito-urinary symptoms. There is slight distension of the abdomen and a slight amount of tenderness in the left lower quadrant. There is no rigidity and no mass is palpable.

After a barium enema it was reported that the upper sigmoid and the lower descending colon were definitely saw-toothed in appearance, indicating an early diverticulitis. Some of the diverticula in the sigmoid retain their barium. The day after admission his temperature dropped and the pain disappeared. He was seen July 14, 1930, at the follow-up clinic and reported as feeling well. He was seen again on October 26, 1930, at which time he was stated to have five attacks of pain similar to the one described above. The taking of some magnesium sulphate seemed to relieve the attack but a definite soreness persisted across the lower abdomen after the immediate attack had passed away. Nausea sometimes accompanies these attacks but he has only vomited once. He has continued working.

This case was placed in Group A—acute diverticulitis without perforation or complication.

CASE XXV—W J, male, fifty-two years of age, was admitted to the hospital June 12, 1930, with a two-months history of pain in the region of the umbilicus and in the left lower quadrant of the abdomen. The pain occurred in attacks and was accompanied by some elevation of temperature. Prior to this two-months period he never had any attacks. The abdomen was slightly distended and there was a moderate amount of tenderness and rigidity in the left lower quadrant.

After barium enema it was reported that the sigmoid and descending colon were very spastic and there were numerous bud-like shadows extending from the lumen of the bowel, indicating an extensive diverticulitis. (Fig 7)

Course in the hospital was quite satisfactory for the pain in the left side of the abdomen gradually subsided and the temperature returned to normal. He was discharged improved.

*Laparotomy Performed*—The upper part of the sigmoid for about four inches was markedly thickened and hard and the mesocolon infiltrated with hard nodules. The entire large bowel as far back as the cæcum was markedly thickened and distended. Resection of the sigmoid with subsequent anastomosis of the distal portion of the bowel to the cæcum. Drain inserted to the site. Convalescence entirely satisfactory.

Pathologic report (Path No 19,727) was diverticulitis of the sigmoid colon with stricture of the colon. Grossly, the specimen consists of a portion of the sigmoid colon about fifteen centimetres opened longitudinally. A little above the middle of its length is a constriction, and at this point the bowel measures four centimetres in inner circumference, the normal circumference being about ten centimetres. In the middle of the constricted part is a narrow opening that leads into a narrow diverticulum. Microscopic examination of the diverticulum wall shows it to be lined with granulation tissue that is infiltrated with numerous plasma round cells, eosinophiles and in some places



FIG 8



FIG 9

FIG 8—Radiograph of Case XXXII. Chronic diverticulitis without perforation or complication. Film No 80 203 shows a large number of diverticula filled with barium in the course of the descending and sigmoid colon.

FIG 9—Radiograph from Case XXXIV. Chronic diverticulitis without perforation or complication. Treatment was conservative. Barium enema reported (No 96 957) that the colon filled completely but from the junction of recto sigmoid upward to the lower descending colon there is a narrowing and irregularity of this region. The bowel is quite saw toothed and suggests an early diverticulitis.

many polymorphonuclear leucocytes. The section of the sub-mucous tissues taken at the point of constriction shows similar inflammatory changes.

This case was placed in Group E—diverticulitis with stenosis.

CASE XXXI—H K, male, fifty-two years of age, was admitted to the hospital July 17, 1917, with a vague gastro-intestinal history. Full details were not obtained.

*Laparotomy Performed*—At operation there was a mass the size of a walnut found in the wall of the descending colon. Two loops of small intestine were found to be adherent to the mass and were freed. The mass was excised and the defect repaired. Cigarette drain placed to the site.

Pathologic report (Path No 21,470) stated diverticulitis of the descending colon. Microscopic sections show a portion of the mucosa with evidences of a catarrhal inflammation—round-cell infiltration of the sub-mucosa, muscularis and the adjacent fat tissue.

This case was placed in Group D—chronic perforated diverticulitis with abscess.



narrowing and irregularity of this portion Area quite saw-toothed and is characteristic of an early diverticulitis (Fig 9)

This case was placed in Group B—chronic diverticulitis without perforation or complication

CASE XXXVI—E W, female, forty-three years of age, was admitted to the hospital May 25, 1927, for the first time, with the complaint of pain and the presence of a palpable tumor in the lower abdomen just above the pubis She stated that for the two-weeks interval preceding her entrance to the hospital she had noted a fullness in the lower abdomen associated with some burning pain at the site of the fullness She had not been constipated but had had the sensation of incomplete evacuation following her bowel movements Attacks of flatulence on occasion A mobile mass could be felt in the suprapubic region

*Laparotomy Performed*—Operation revealed, in addition to multiple fibroids of the uterus, a perforating tumor of the sigmoid This mass occupied the lower portion of the sigmoid flexure and was adherent to the parietal peritoneum There was also a partial constriction of the sigmoidal lumen There were no perceptible surrounding lymph-node involvements A supravaginal hysterectomy and a first-stage Miculicz' operation were performed Five days later (May 31, 1927), the second stage of the Miculicz' operation was done

Her post-operative course was stormy A posterior colpotomy was required for the evacuation of a collection of purulent material in the cul-de-sac of Douglas A transfusion of 500 cubic centimetres of whole blood was given Anti-lytic treatment was also instituted She was allowed home on the forty-third post-operative day and was to return at a later date for the closure of the intestinal fistula (Third-stage Miculicz')

Re-admitted to the hospital three months later (August 2, 1927) at which time a closure of the draining fistula was performed Subsequently the fistula re-opened and she was allowed home on the twenty-second day after operation She was seen in the follow-up clinic October 15, 1927 Her condition was very satisfactory The fistula had not closed but the discharge was constantly decreasing in amount and she was having normal bowel movements She reported again in December, 1927, as being in excellent health Had gained in weight Sinus was not completely closed Condition satisfactory

Pathologic report (Path No 35 958) was Chronic perforation of the sigmoid colon Grossly, the specimen consists of a short segment of colon, the wall of which is infiltrated with hæmorrhage There is also some inflammatory reaction in the fat Microscopic examination revealed ulceration and inflammatory reaction in wall of the gut and in the surrounding fat

This case was placed in Group D—chronic perforative diverticulitis with abscess formation

ACKNOWLEDGMENT—The authors wish to express their appreciation to Dr Eugene Pool for his kindness in permitting them to use the cases from the Second Surgical Division of the New York Hospital, to the Röntgenologic Department for their excellent cooperation in securing photographs of the radiographic plates and to the Department of Pathology for the photomicrographs included in this article

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# BACTERIOPHAGE IN SURGERY OF THE COLON AND RECTUM

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ACKNOWLEDGING a certain susceptibility to the contagious enthusiasm of d'Herelle for the clinical application of bacteriophagy, and having been inoculated in listening to d'Herelle's Lane Medical Lectures in 1928, we have looked to the bacteriophage with some degree of hope as a possible resort in some of the terrible problems of infection that every now and then confront the surgeon

We are fortunate in having in Stanford University a so-called Bacteriophage Research Laboratory, of which Professor E W Schultz is director Part of the research work of the laboratory is in the application of bacteriophagy in the field of clinical medicine, and the laboratory offers its services in determining the susceptibility to lysis of bacterial cultures sent by physicians

The various kinds of bacteria in the culture are plated and each kind of bacterium is inoculated with a drop of bouillon suspension of a number of phages known to cause lysis of bacteria of the same sort and note made of the particular ones which cause most active lysis of the culture and a suspension of this particular phage or group of phages is furnished the clinician For this service a nominal charge is made to assist in the support of the laboratory

One reads in the literature such enthusiastic reports of clinical response to treatment by bacteriophage in so wide a variety of infections that if one belongs to the more confiding portions of the medical profession he is tempted to look to bacteriophage almost as a panacea for all bacterial ills, and yet when one talks with his friends he hears such discouraging reports and learns that one after another has given it up after conscientious trial that he wonders just where the virtue and truth lie Is it blind enthusiasm on the one hand or faulty technic on the other? Before essaying a final verdict and although the burden of proof is on the advocate of any new therapeutic measure, the critic can have no standing in court until he can show that his errors of technic have been eliminated

We are told that in certain diseases, *e g*, cholera, bacteriophage therapy is almost specific At least, d'Herelle would claim almost 100 per cent, others (witness reports from Egypt from British sources) would assign a very much smaller percentage However, a strong case is made out for the value of bacteriophage therapy Yet, in other affections, the very contrary obtains

Under these circumstances, items of individual experience, no matter how modest, may become useful contributions

workers of the canal who remarked that "the canals of Holland would seem altogether to disprove the germ theory of disease," there is much promise that a rational administration of bacteriophage may be useful—even effective—in controlling infection with the bacteria of the colon

But the problem of bacteriophage therapy is not as simple as one might suppose. It is not enough to take any phage and administer it to the sick man by mouth or hypodermically or locally. To be effective the phage must fit; it must be "matched," i. e. be shown to cause lysis in the particular culture and strain of bacteria in point. One great defect, therefore, in the practical application of bacteriophagy to clinical problems, is the time required to seek out by trial in the laboratory an active phage for the particular case, for in many such as they occur clinically delay is disastrous.

Then d'Herelle and others have demonstrated that not only do different phages exhibit different degrees of activity, but the individual phage may lose its potency, or on the other hand it may have its potency increased at will by replanting in suitable bacterial cultures.

Again, since most bacteriophages known have been isolated from the intestinal contents or from sewage, it may be taken for granted that any individual phage has been living in the intestinal contents in symbiosis with the bacteria—developing, then, a sort of mutual relation with potency so adjusted to the resistance of the particular strain of bacteria as to set up a sort of balance so that the bacteria are kept in check but not destroyed. Moreover, the bacteria by long association with bacteriophage of perhaps low virulence have acquired new resistance to the activity of the phage. There are individual cultures of common bacteria, even strains of otherwise susceptible cultures which are strongly resistant to bacteriophage.

All this is true to an almost unbelievable extent in relation to the colon *Bacillus*—if one can speak of "the" colon *Bacillus*—a matter which is of supreme importance when attempting to control colon *Bacillus* infections in surgical operations either in prophylaxis or after wound infection has occurred.

Much of the practical difficulty in therapeutic use of bacteriophage and particularly in colon infections is the fact that time is often of supreme importance. Witness the perforated appendix, perforation, operative or otherwise in diverticulitis—where the delay of three or four days necessary to procure a matched phage may be fatal—a circumstance which not only seriously limits the clinical value of bacteriophage therapy, but would seem to relegate it to the field of chronic colon *Bacillus* infections. But here it would seem to be of distinct value, e. g., in chronic, even ulcerative colitis.

In acute infections, then, if treatment by bacteriophage is to be attempted, we are obliged to resort to blind application of mixtures of phages which have shown themselves active in causing lysis in a variety of strains of the colon *Bacillus* in the hope that one of them may "fit."

While, therefore, there is the possibility that a suitable phage may be

When one receives from the laboratory a suspension of bacteriophage, what is it that is delivered? Actually it is a quantity of bouillon in which bacteria have been grown and bacteriophage added, which phage is supposed to have, and ordinarily has destroyed all the bacteria. To guard against possible failure of complete lysis of the bacteria in the culture, and to prevent the application to the wound or hypodermically of virulent organisms, the broth is passed through a Chamberlain filter which normally catches bacteria but passes the smaller bacteriophage. It is conceivable that there is here a danger from the occasional inefficiency of the Chamberlain filter. This danger is known to be small, but it may be real.

Phage suspensions therefore, before use should be limpid clear and before delivery a portion of the batch should be centrifuged and examined, even cultured, for the presence of bacteria.

The vehicle, broth, originally contains a certain amount of proteid, and unless this proteid is entirely destroyed (it usually is), it may give rise to proteid shock or anaphylactic phenomena which, in a patient weakened by sepsis, may be serious. Therefore, only small amounts may be injected subcutaneously, 2 to 3 centimetres, and the intravenous use, justified only in desperate conditions, but there most dangerous for the reasons stated, would best be avoided until the problem has been more completely worked out.

In a case recently reported by a colleague, that of a child suffering from serious staphylococcal osteomyelitis, after repeated intravenous injections of phage suspension the child recovered and the osteomyelitis speedily cleared but the injections were followed by shock and rise of temperature to 106° F so one wonders as to the safety of the procedure.

Because of the variation in activity of bacteriophage in relation to the variety and strain of bacteria, results may be expected only from the more active strains of bacteriophage and experience bears this out. Moreover, experience shows that bacteriophage notwithstanding its extreme penetrating capacity, is more reliable when administered in considerable amounts locally than when given subcutaneously.

And again the effect is often only temporary. Perhaps not enough emphasis has been placed on the value of repetition of the administration at not too long intervals until recovery.

The following cases, too few to warrant conclusions, are nevertheless suggestive.

CASE I—A N, aged sixteen. *Acute perforating appendicitis, wound infection, pelvic abscess*. Six days after operation drainage of foul pus. Leucocytes 21,000 to 25,000, 90 per cent polymorphonuclears. One cubic centimetre suspension of stock bacteriophage known to be active against colon *Bacilli* injected into the arm, four cubic centimetres, into the peritoneal cavity between adherent coils of intestine. Two days later pelvic abscess was opened in left groin evacuating 500 cubic centimetres of thin foul pus, mixed culture of *B. coli* and non-hemolytic streptococci. Drainage profuse and continuing. Four cubic centimetres of matched bacteriophage (anti-colon bacillus phage) injected into wound. In forty-eight hours drainage markedly less, odor notably

dermically in arm, 4 cubic centimetres instilled into wound. A few hours later the temperature which had averaged between  $99\frac{1}{2}^{\circ}$  and  $100\frac{1}{2}^{\circ}$  for a week, rose to  $102^{\circ}$  on two successive evenings, and thereafter slowly subsided.

July 17 bacteriophage 5 cubic centimetres instilled into wound. This was followed by a similar rise of temperature for three nights after which the fever subsided and remained normal. The phage used was stock-pooled coli phages Nos 1 and 2 of the Stanford Laboratory which on first two passages gave but incomplete lysis. On the third passage the lysis was complete. It was this filtrate that was injected. The discharge rapidly ceased, patient was out of bed five days later. August 5 left hospital. The recovery was so prompt after the injection of the phage that it seemed more than evident that the phage deserved much credit.

CASE VI—V T, age seventy-one. *An immense abscess filling pelvis and lower abdomen.* X-ray examination impossible because barium could not be induced to pass beyond the rectum. Temperature normal, leucocytes 9,000, November 13, 1930. Operation evacuating more than a litre of four mucopurulent material, probably due to slow perforation of a diverticulum although carcinoma could not be excluded. Culture gave only a few Gram-negative bacilli. Culture showed *B. coli*. Lysis was complete with polyvalent anti-coli bacteriophage mixture No 18 of the Stanford Laboratory. November 18 and 19 2 cubic centimetres of this phage suspension were injected hypodermically, several cubic centimetres instilled into the wound. Slight rise of temperature  $100\frac{1}{2}$  for two days. There was a very marked and almost immediate change in the character of the discharge. In particular the foul odor almost completely was destroyed. Four days later, however, there was again a rise of temperature and pulse rate. Otherwise than the change in the discharge there was no assignable effect of the phage. Liver or subphrenic abscess developed, patient became deeply septic in spite of further opening and drainage. Patient gradually went down and died February 18, 1931. The phage was used once or twice subsequently towards the end of the illness. In this case it would seem that the phage was not given a fair trial. It should have been used many times instead of twice early in the illness.

CASE VII—G T, aged fifty-seven. Immensely fat. *An acute diverticulitic abscess in the mesentery.* December 27, 1928, operation by another surgeon showed abscess size of a hen's egg in the mesentery of the sigmoid. Next day the abscess was opened and the intestine opened also, as in colostomy. Three months later an attempt made to close the colostomy. The wound broke down.

March 23 stock phage, not matched, instilled into wound. No noticeable effect. March 28 pus containing a variety of bacteria *B. coli* were isolated. *B. coli* phages were tested but gave only partial lysis. Complete lysis was given by a phage recently isolated from sewage. Matched phage 2 cubic centimetres intradeltoid. Some instilled into the wound. No noticeable effect. The colostomy remained open and two and a half years later a second attempt was made to close it. It might have been well to have made culture from the patient's intestinal contents isolating the principal bacteria and to have tried to have found phages which would be active against them. However, having on hand a quantity of anti-*B. coli* phage from the previous case (Mrs V T) several cubic centimetres of this were poured into the wound before closure. A fulminating infection followed. A gangrenous streak the width of one's hand rapidly formed and led from the wound around the flank as far as the mid-line. Culture showed a variety of organisms, *B. coli* and non-hemolytic streptococci predominating. The latter failed to grow on sub-cultures, no Gram-negative bacilli were found suggesting anaerobes, nor was there growth in anaerobic culture. Cultures of the *B. coli* were subjected to the polyvalent anti-coli mixtures. There was no lysis of any culture, the bacteria being completely resistant to the phage. There seemed no use, therefore, in administering the phage at this time. In spite of wide incision, the gangrenous process extended and patient succumbed sixteen days after the operation.

This case brought up the interesting question as to whether the colon bacilli had

## DIVERTICULITIS AND SIGMOIDITIS

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THESE two conditions are secondary to the presence of diverticuli in the wall of the sigmoid, so-called diverticulosis. A distinction is made because in some patients no gross diverticuli are visible, either by X-ray or on the operating table, and one finds only a thick-walled, red, œdematous sigmoid. Nevertheless the same etiologic factor is present in both.

Diverticulosis of the sigmoid and colon is usually looked upon as a rather innocuous condition to which little attention has to be paid. It is considered to be interesting rather than important. The etiology of the condition has aroused a great deal of curiosity and various explanations have been offered for their origin. That they are acquired false diverticuli seems well established. They increase in frequency as age advances, most of them being observed between fifty and seventy. It seems to be some change in the wall of the gut, perhaps due to stretching of a weakened muscular wall which allows these small bud-like projections to prolapse. As long as they empty regularly they produce no symptoms at all, or at most a slight feeling of fulness and discomfort with gas distension. Stagnation, however, may easily occur in these little pockets and it is this which makes them visible on Röntgen-ray films (Fig 1). In case this stagnated material becomes putrefactive and causes irritation a group of symptoms is initiated which require medical or surgical attention. It is this class of patients with which this paper is concerned.

Although diverticuli may be present along the entire course of the colon usually only those in the sigmoid produce symptoms. This is probably due to the narrow lumen and the frequency of stagnation at this point. In what proportion of cases, with acquired diverticuli of the colon and sigmoid pathologic changes occur which produce symptoms, is difficult to say, largely because we have no accurate statistics as to the frequency of diverticulosis. In some hospitals it has been observed much more often than in others. Hames<sup>1</sup> states that during the year 1925 one case of acute diverticulitis with perforation was observed in the Cincinnati General Hospital and that during the years 1915-1925 two cases with diverticulosis were found at autopsy. Since he states that the hospital admits 10,000 cases annually, of which number 20 per cent are surgical, this records only three cases in 20,000 patients. Newton<sup>2</sup> on the other hand reports forty-four cases of proved instances of diverticulosis and diverticulitis in 56,000 cases admitted to the Peter Bent Brigham Hospital, Boston, over a period of fourteen years. This means one case in about 1,300 patients. William J Mayo<sup>3</sup> states that records at his clinic show a total of 2,139 cases of diverticulosis. Among 31,838 X-ray

nally and lead to abscess formation or peritonitis. It may dissect between the layers of the wall of the sigmoid until a large segment becomes involved forming a palpable tumor. Frequently, adhesions are formed to the abdominal wall, the bladder, or loops of small intestines, and these may lead to perforation into one or the other viscus with resulting internal fistulæ. At times the blood-vessels of the wall may become thrombosed, resulting in necrosis with perforation, or a pyelephlebitis may extend to the liver. The cellulitis of the wall of the sigmoid itself may lead to obstructive symptoms or adhesions of surrounding loops of gut may produce angulation and obstruction. There is no limit to the serious surgical complications which may result from acute sigmoiditis or diverticulitis.

It is possible to divide the cases clinically according to the pathologic changes and the course they are following into

- 1 Simple diverticulitis and peridiverticulitis which subsides without operation
- 2 Diverticulitis with complications resulting from perforation such as abscess, gangrene, peritonitis and fistulæ
- 3 Diverticulitis resulting in intestinal obstruction
- 4 Diverticulitis associated with carcinoma

The patients belonging to group one are in a way the more interesting from a diagnostic standpoint. The symptoms may be mild or they may be so severe as to be alarming. Some of these patients complain only of pain over the left lower abdomen, sometimes abdominal cramps, gas distension, a feeling of spasm, with associated constipation perhaps alternating with diarrhoea. They are not acutely ill. On examination one may find some tenderness along the sigmoid, but nothing else. In other patients the pain may be sharp in character and shoot through the lower left abdomen, and one may find considerable tenderness over that region. Then there is a group of cases in which the symptoms are more distinctly of an inflammatory nature. The pain may be very severe, the patients sometimes state they feel as if they are going to die. A condition of shock may be present. There is definite tenderness and rigidity over the left lower abdomen and frequently in the suprapubic region. There is a rise of temperature, perhaps to 100° or 101°, and blood examination shows leucocytosis. Cramps, vomiting, and urinary symptoms may be present. Very often there is a palpable tumor which may extend upward as far as the umbilicus and may be mistaken for an ovarian cyst or tubo-ovarian disease. If the symptoms have persisted for some time, there may be loss of weight. Bleeding or discharge is uncommon. If present, it may suggest carcinoma. Experience has shown that carcinoma is not often associated with diverticulitis, but nevertheless it has to be borne in mind. A history of recurrent attacks rather than a steadily progressive one, as usually found in carcinoma, will help one in reaching a correct diagnosis.

several of these patients finally had to be operated on, while still others were admitted as surgical emergencies and had to be operated on at once

All patients were over forty years of age, only five being between forty and fifty, seven between fifty and sixty, nine between sixty and seventy, and three over seventy

There were thirteen men and eleven women in this group

It may be of interest to note that the majority belonged to the rather well-to-do class, twenty being private and only four ward patients. There was, however, nothing in their method of living which could be held responsible for the development of symptoms. Adiposity does not seem to be a factor

*Symptoms and Physical Signs*—In order of frequency the following symptoms and physical signs were noted

1 Pain	24 patients	8 Vomiting	9 patients
2 Fever	18 patients	9 Obstruction	8 patients
3 Constipation	14 patients	10 Perforation	7 patients
4 Palpable Tumor	11 patients	11 Urinary Symptom	6 patients
5 Cramps	11 patients	12 Loss of Weight	6 patients
6 Leucocytosis	10 patients	13 Diarrhœa	6 patients
7 Gas	10 patients	14 Bleeding	6 patients

1 Pain was complained of by all and was usually the outstanding symptom for which surgical aid was sought. It varied a great deal from steady pain situated in the left lower quadrant to cramp-like pain associated with incomplete or complete obstruction. It naturally varied with the existing pathological changes. In ordinary uncomplicated sigmoiditis or diverticulitis with thickening of the wall of the gut, and perhaps a palpable tumor, the pain may not be bad, but it may be extremely severe, cramp-like in character and associated with symptoms of shock. Patients sometimes feel as if they are going to die. The clinical picture is an interesting and alarming one, and after having been seen several times will aid one in the diagnosis in favor of sigmoiditis rather than tumor. The pain is apparently due to an intense spasm of a segment of gut. If perisigmoiditis develops or a perforation takes place with resulting abscess or peritonitis, pain and soreness due to the involved peritoneum may become more evident.

2 Temperatures over  $99^{\circ}$  were considered fever. Six patients had between  $99^{\circ}$  and  $100^{\circ}$ , while twelve had over  $100^{\circ}$ . In the uncomplicated cases the fever usually varied between  $100^{\circ}$  and  $101^{\circ}$ , while in those with complications it reached  $103^{\circ}$ – $104^{\circ}$ , or even  $105^{\circ}$ . The higher degrees were usually found in patients with perisigmoiditis, or peritonitis and abscess formation, but it is interesting to note that in two patients with very high fever continuing for weeks no peritonitis was present. There was an extensive infiltration of the wall of the gut which in one of them had extended to the bladder wall, the mesentery and the abdominal wall. All cultures from the tumor bed, from the involved lymph-nodes and from inflamed appendices epiploica were negative, and no organisms were seen in the smear. One



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interest is the rapidity with which a large, tender mass may subside under best treatment, external applications and careful rectal irrigations (Fig 1) In case perforation takes place with abscess formation, drainage may be established

5 Cramps may be very severe and are often aggravated by taking a laxative They are due to spasm of the affected portion of gut, or to intestinal contractions resulting from an obstructive lesion Those due to spasm seem to be the most painful



FIG 5—Gelatinous carcinoma in the presence of multiple diverticula Complete obstruction had resulted Resection was done

6 Leucocytosis is frequently found, especially in patients with fever It may be unusually high, with a high polymorphonuclear count The higher counts have not been an indication of the presence of pus, but have been found in patients in whom prompt subsidence of symptoms occurred after a few days without abscess formation The highest count reported was 48,800 with 90 per cent polymorphonuclears, which was verified by having it repeated This patient was operated on while she had a temperature of 103° No pus was found but there was an extensive cellulitis of the wall

9 Obstruction may occur and may be incomplete or complete. It may be due to the mass itself which, by thickening of the wall and hyperplasia associated with the inflammation, brings about an incomplete or complete obstruction, or it may be due to angulation of loops of small gut which have become adherent to the inflamed sigmoid.

In five of our cases, obstructive symptoms were partly due to adhesions angulating loops of small gut. They could be separated and that element of the obstruction relieved. In one of them a portion of small gut had to be resected. In another there were two separate obstructions, one resulting from the sigmoid mass, the other from angulated small intestines. The diagnosis of the two conditions could be made before operation. Four patients had incomplete obstruction due to the mass itself, and five had complete obstruction. In two of the latter the pathological examination revealed an associated carcinoma (Figs 5 and 6).

10 Perforation took place in seven patients. In three there was local abscess formation. In two of these the abscess was plastered against the wall of the gut and could be lifted out with the tumor mass, while in the third case a large abscess developed which contained pus and gas and had to be opened externally.

In four patients an acute perforation took place into the free peritoneal cavity. One of them was drained early and recovered, another was treated expectantly for peritonitis without knowledge at that time of the underlying cause, and finally recovered, while the other two died.

11 Urinary symptoms were present in six patients. Whether in each case these symptoms had any definite relation to the sigmoiditis is not possible to state. In one female patient the bladder wall was definitely involved, but no perforation had occurred. In another female patient there were extensive peritoneal adhesions involving also the bladder. The other patients were men, in whom the prostate may have played some role. In one male patient, however, the symptoms were sufficiently severe to suggest calculus, and X-ray examination with catheterization of ureters was done to rule that out. In another old patient a diagnosis of carcinoma of the sigmoid with perforation into the bladder had been made, but examination showed the colon lesion to be a sigmoiditis, and the bladder affection a cystitis secondary to the sigmoiditis.

12 Loss of weight was a factor in only a few cases in whom long-continued inflammation with associated digestive disturbances or an associated carcinoma were responsible.

13 Diarrhoea was not a common symptom and was never severe. In some patients it alternated with periods of constipation.

14 Bleeding. In six patients gross blood had been noticed from time to time. Whether in all cases it had its source at the site of the sigmoid lesion could not be definitely determined.

In one patient a gangrenous inflammation of the sigmoid with vessel changes was present.

In another patient, in whom a resection was done, *Bacilli enteritidis* was isolated from a small abscess in the wall. No anaerobic organisms were found. Gram-positive cocci were found in the stained-tissue sections.

*Course of the Disease*—Of the twenty-four cases reported, eleven have so far not been operated on. Several of them had only one acute attack which subsided with appropriate medical treatment while a few have been under observation several times.

At the time of discharge all of these patients were informed of the pathological condition underlying their complaint and they were made familiar with the measures calculated to avoid recurrence, such as the use of mineral

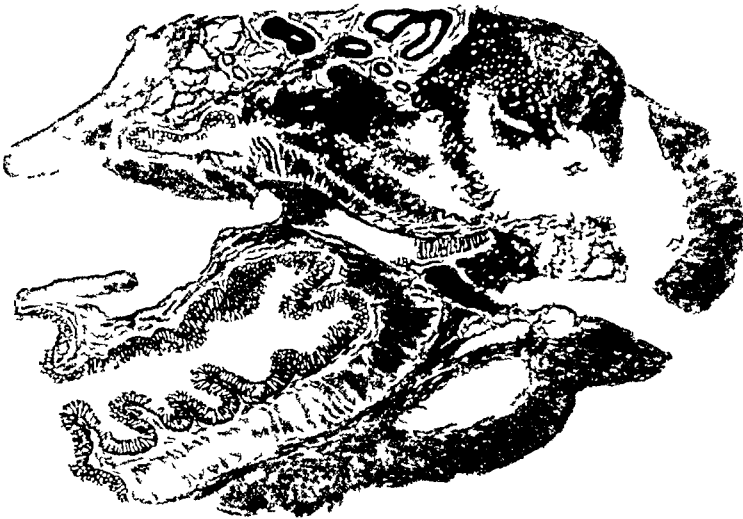


FIG 8—Cross section of colon ( $\times 20$ ). The larger lumen is that of the gut. Above it is an acute abscess (in a diverticulum) the walls of which are partially lined by intestinal mucosa. The remaining portions of the mucosa have been destroyed by the suppurative process.

oil to insure a daily evacuation, avoidance of food with a large residue, and avoidance of overeating. That these measures apparently have some success is evidenced by the fact that most patients have remained free from recurrence. On the other hand, the recurrences have shown that there is no positive safeguard in avoiding acute sigmoiditis or diverticulitis in those patients afflicted with diverticulosis. The condition must be considered a serious one and one must be prepared at any time to see a recurrence or a complication requiring surgical intervention.

In thirteen of the twenty-four patients some kind of surgical interference was indicated or became imperative. Some of these patients had been under observation for a long time and were known to have diverticulosis, while others were seen for the first time during the acute surgical emergency.

*Treatment*—Patients with temperatures under  $100^{\circ}$  and those with no fever at all were treated ambulatorily. They were put on a light diet with little residue, and mineral oil was ordered for morning and evening. Rectal irrigations were given when indicated and perhaps local applications of heat

*Pathological Examination of Tissue*—The gross specimens removed in cases of sigmoiditis show a red, hard, often rather nodular tumor. The appearance is due to thickening of the wall, involvement of the appendices epiploica and diverticulæ, as well as adhesions of surrounding tissue. Frequently, there is a fibrin deposit and there may be an encapsulated abscess. The serosa is usually rough and granular. On opening the specimen it is surprising how little actual obstruction exists. The mucosa may be normal, or it may show redness and superficial erosions, but no real ulceration. It is at once evident that the lesion does not arise in the mucous membrane as in the carcinoma, but is confined to the wall and perisigmoid tissues. Although sometimes a good-sized diverticulum is found, perhaps filled with pus, it is not always possible to demonstrate openings into diverticulæ or even into a single diverticulum. This corresponds to some of the X-ray find-

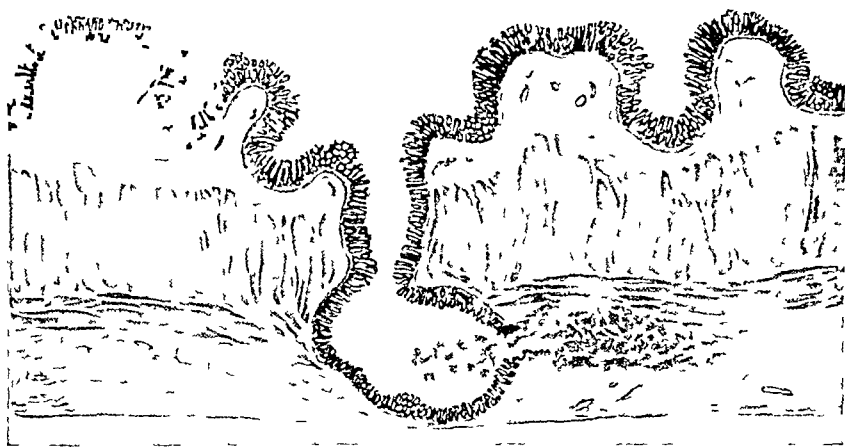


FIG 9—Semidiagrammatic presentation ( $\times 200$ ) (after Aschoff). The diverticulum has penetrated to the serosa. A perforation of the diverticulum has occurred.

ings in acute cases in which no definite diverticulæ are shown, but only a narrow lumen with an irregular filling defect. Pressure on such a specimen may cause oozing of retained feces or purulent material from several small ducts in the wall, which are not visible on the serous surface of the gut as diverticulæ. They seem to be buried in the thick oedematous wall of the sigmoid. It has seemed to us that during the early stage, while a diverticulum is pushing through the wall of the gut, and before it becomes visible on the serous surface, it may become infected and perforate. But instead of perforating externally beyond the serous surface to form a peridiverticulitis or peritonitis, it may perforate laterally into the wall of the sigmoid where the infection spreads between the layers. This probably accounts for some of the extensive tumefactions of the sigmoid which can be felt through the abdominal wall. In two of our specimens we were able to demonstrate these intra-mural abscesses (Figs 8, 9, and 10).

The microscopical examination of all resected specimens showed diverticu-

sigmoid was exposed, partly covered with fibrin. Loops of small gut were adherent on the mesial side. Upon separating them there was a gush of foul-smelling pus from a large abscess. In contact with this the wall of the sigmoid, over an area the size of a silver dollar, was gangrenous and flaccid. Pus had extended upward between the loops of intestines along the posterior abdominal wall and in the left lumbar gutter. To prevent further leakage and later be able to resect the affected gut, a first-stage Mikulicz operation was done. The arteries of the mesentery were found normal but several veins were thrombosed. Ample drainage was established. In spite of this the condition did not improve. Temperature rose to  $107^{\circ}$  and the patient died on the fourth day.

*Pathological Diagnosis*—Chronic sigmoiditis, acute suppurative perisigmoiditis. Sections stained for bacteria showed gram-positive bacilli and cocci.

CASE II—Mr. G. E., fifty-three years old, gave the following history. Abdominal distress lower left quadrant for three months, associated with soreness. No medical attention. Bowels normal. No urinary symptoms. Increased pain and fever for nine days. Became worse six days ago, had to go to bed and consulted his physician.

*Chief Symptoms*—Pain and discomfort lower abdomen, vomiting, and chills and fever. One severe chill four days ago following rectal irrigation. Diverticulitis had been suspected and an attempt had been made to improve his condition sufficiently to transfer him to the hospital for X-ray examination. Blood count had been low. He had apparently improved, and on the morning of admission he felt quite well, had normal temperature and was sitting out of bed. Early that afternoon he had a sudden agonizing pain in the left lower abdomen, he became covered with perspiration and developed a chill lasting half an hour. Temperature rose to  $104.5^{\circ}$ . After this, pain continued severe and the abdomen became enormously distended. The patient was seen by us about five hours after this acute onset. With the history of left-sided pain a diagnosis of peritonitis secondary to diverticulitis was made. Immediate operation done. Thin pus with colon odor was present under pressure. Loops of small intestines were acutely inflamed matted together with fibrinous exudate, and pus flowed from every direction. Chief focus of infection was in the left lower quadrant. The sigmoid was a hard, infiltrated tumor mass bathed in foul-smelling pus. No gross perforation found. Pus removed by suction. Extensive drainage instituted. The peritonitis did not clear up. Heart and kidney complications developed and the patient died on the eleventh day. The culture showed colon bacilli and short chain streptococci.

CASE III—Mrs. M. P., sixty-eight years old, had been under observation for a long time on account of nausea, vomiting, loss of weight and constipation associated with pain in the lower bowel. An X-ray diagnosis of multiple diverticulæ of the sigmoid with obstruction had been made. When she came under our care she had been kept alive entirely on intravenous glucose injections and hypodermoclyses. She had apparently a very marked reverse peristalsis with fecal vomiting. The first stage of a Mikulicz operation was done under Pernoxon anesthesia and a small opening immediately made in the gut to favor drainage. There was no improvement. The involved area was then resected, but vomiting continued. Transfusion and feeding into the colon did not improve the general condition. She died eight days after operation from general asthenia. The specimen presented numerous diverticulæ filled with hard concretions. At one place the lumen was completely obliterated by a semi-gelatinous translucent tissue which was later reported gelatinous carcinoma (Fig 5).

CASE IV—Mr. N. D., seventy years old, was operated on by us in 1926 for a right subphrenic abscess and a liver abscess of amœbic origin. He had some intestinal symptoms at the time, but they were insignificant compared with his chief complaint. He recovered and gained much weight. After a while he began to have attacks of pain over the left lower quadrant, associated with constipation and discharge of blood and mucus. Proctoscopy and X-ray examination showed a filling defect with irregular configuration (Fig 7).

The patient reacted well. The cœcostomy began to function and gas and fæces were also passed through the rectum. Temperature, however, continued, and after a while a tender mass developed in the left lower abdomen. Conservative treatment was continued, supplemented by X-ray and vaccine treatment until the impression was gained that a perisigmoid abscess had formed. An operation was done for this condition but no pus was found, just hard infiltrated inflammatory tissue. Later a perforation of the sigmoid developed spontaneously on the left side with fecal discharge. It became apparent that it would never be possible to resect the involved sigmoid on account of the extensive involvement and the numerous adhesions. A permanent colostomy was therefore done as close to the lesion as possible, and the cœcostomy closed. After a while the patient became ambulatory but she remained an invalid and died about a year after the first operation.

The remaining eight patients who were operated on are living. On account of the interest attaching to them a short report of each is given.

CASE I—Miss V. L., forty-eight years old, had for two years complained of severe attacks of cramps in the left lower quadrant, associated with tenesmus and at times diarrhœa. Examination showed tenderness over the sigmoid, but no mass. Rectal temperature varied from  $99^{\circ}$ – $102^{\circ}$ . Examination of the fæces was negative for blood. Repeated X-ray examinations showed constant irregularity and narrowing of the lumen of the sigmoid with retention of barium. A diagnosis of sigmoiditis was made, and on account of suspicion of carcinoma an operation was advised and performed by another surgeon. An inflammatory condition was found and the abdomen was closed without drainage.

CASE II—Miss A. S., forty-eight years old, was first seen four weeks after the onset of an acute disease which was at first diagnosed as influenza, and after a few days as pelvic peritonitis of unknown origin. She had been confined to bed all this time and had run a temperature of  $103^{\circ}$ – $104^{\circ}$ . She had complained of vomiting and pain over the lower abdomen, associated with urinary difficulty and constipation. A daily rectal irrigation had brought some relief, but only a little fluid could be introduced at a time. She looked sick and very anæmic. The temperature was  $103^{\circ}$ , and the pulse 104. The general examination was negative. In the lower left abdomen a tender mass could be felt which apparently arose from the pelvis and extended upward to the level of the umbilicus. Vaginal examination showed the uterus and right adnexa normal, while on the left side a mass could be felt, situated high, and apparently plastered against the lateral pelvic wall. It was very tender. Rectal examination verified these findings. A diagnosis of sigmoiditis was made and an operation advised.

Through a median suprapubic incision an interesting picture presented itself. A large, red, nodular sigmoid tumor was adherent to the lateral pelvic wall. An infiltrative process extended from here into the anterior abdominal wall and the urinary bladder, to both of which the tumor was adherent. By careful blunt and sharp dissection the tumor was gradually separated from the bladder and then from the pelvic wall. There was no abscess present. After freeing it, the mass could be drawn upward for about 3 inches away from the bed where it had been adherent. The wall of the gut itself was thick and œdematous, and the appendices epiploica and the mesentery were extensively involved. A culture was made from the tumor bed and one of the inflamed appendices, as well as several enlarged lymph-nodes, were removed for culture and section. All these cultures and sections were subsequently reported negative. The bladder slipped back into position. The pelvic organs were found to be normal. The appendix was removed. A cigarette drain was inserted into the tumor bed and the normal sigmoid placed over it, while the inflamed sigmoid was left free at a higher level where it would most likely not form new adhesions. After a few days the temperature came down, but did not reach normal for several months. During all this time there was a moderate amount of drainage containing streptococci. At times the

loop of lower ileum was adherent in the pelvis and so angulated as to cause incomplete obstruction. After separating it a perforation was found at the apex of the angulation. Whether this was entirely the result of manipulation could not be determined. It was considered that it might be an old perforation and the cause of the general peritonitis (This was later disproved because no ulceration was found in the lumen). The affected portion of gut, about 8 inches, was removed and an end-to-end anastomosis done. No other pathology found. Drainage was established and the abdomen closed.

The convalescence was uneventful. A sinus persisted for a long time and was later excised. She was well for about four years, when she developed severe cramp-like abdominal pain and vomiting. She was re-admitted five days after the onset. The abdomen was distended. A good-sized ventral hernia was present but was easily reducible and apparently not concerned in the symptoms. There was slight tenderness and rigidity over the entire lower abdomen, but on the left side there was marked tenderness and rigidity and an ill-defined tender mass. The temperature was  $102.2^{\circ}$ , pulse 108, white blood-cells, 17,500, polymorphonuclears, 85 per cent. A diagnosis of probable sigmoiditis was made. Conservative treatment was followed and in about ten days the temperature was normal. A barium clysis showed a long, narrow, channel in the sigmoid region which appeared to be due to spasm. No diverticula were visible. There was retention of barium.

An operation was performed, primarily to repair the ventral hernia, and secondarily to explore the abdomen. It was interesting to note that all signs of the old peritonitis had disappeared. There were no adhesions and the site of the end-to-end anastomosis could not be identified. A large, nodular, tumor was found in the sigmoid. It was red and apparently an acute sigmoiditis. No free fluid or pus present. Tumor not disturbed, but the hernia was repaired. The patient has remained well. It was considered that the original attack of peritonitis was secondary to sigmoiditis.

CASE IV—Mr. M. L., seventy-five years old, was seen July 15, 1929, on account of suspected intestinal obstruction. His chief complaint was constipation and abdominal distension. He had not had a real movement for ten days. He had cramp-like pain and hiccough. The temperature was  $99.6^{\circ}$ , pulse 68. He had not lost weight. X-rays had been made a few days before. They showed very much distended large and small intestines. A barium clysis outlined very marked narrowing and deformity of the sigmoid. The abdomen was enormously distended and tympanitic, and one could see the outlines of the large loops of gut. No detail could be made out. Diagnosis of obstruction was made, probably due to carcinoma of the sigmoid.

A cæcostomy was done to give relief and allow more careful examination later. The gut was opened immediately and a large quantity of fluid, frothy feces evacuated by suction. Hiccough stopped at once and the size of the abdomen diminished. There was a sharp febrile reaction for a few days. During the next few days drainage through the tube diminished, and feces and gas began to be passed per rectum. Repeated X-ray examinations have been made since. There is no evidence of carcinoma. Barium clysis shows a peculiar irregular worm-eaten area at the junction of the descending colon and sigmoid, associated with a severe spastic condition of the colon which has been diagnosed as an inflammatory lesion. The patient has remained well with the cæcostomy tube in place. There is only a very little discharge. The bowels move well. An attempt was made some time ago to close the cæcostomy, but it resulted in a recurrence of the sigmoid symptoms and made reopening necessary. The age of the patient and his general condition make a resection inadvisable.

CASE V—Mr. C. R. first came under our care in 1923, when he was forty-four years old. He complained of attacks of abdominal pain which he had been having for several years. The pain was at times quite severe, and localized in the left lower abdomen. There was no vomiting. There was always trouble with gas which seemed to stick on the left side. The bowels moved fairly well, but the stool was thin and ribbon-like of late. There had not been any blood. No loss of weight. Examination showed

forating diverticulum which had formed an abscess in contact with the walls. Surrounding the opening of the diverticulum was a flat carcinoma, later reported gelatinous carcinoma (Fig 6)

The patient is still under care but is doing well

CASE VII—Mrs E V came under our care in 1916 when she was sixty-one years of age. Five years previously she had had a resection of the sigmoid done by one of my colleagues for what was supposed to be carcinoma but later reported sigmoiditis. An anastomosis had been done but on account of leakage, infection developed, requiring prolonged treatment and eventually a permanent colostomy. The colostomy functioned well. A sinus was present in one of the scars of the abdomen and led down to the rectal stump. The anus had contracted so that examination was not possible. Fluid injected into it escaped through the abdominal sinus. The patient's chief complaint was cramp-like abdominal pain associated with discharge of pus from the sinus. She was operated on and the sinus tract was completely excised down to the stump of the rectum which had been allowed to stay in. The gut was closed and the wound eventually healed. The anus was stretched to allow drainage downward. After this the patient was well until 1929 when she again began to have attacks of abdominal pain. At first they were attributed to the gall-bladder which was known to be filled with stones, but later the symptoms were more definitely intestinal in character. Gradually the pain became worse, and the patient felt as if gas stuck in the intestines and could not be expelled. Then tenderness developed over the lower abdomen to the inner side of the colostomy and after a while a mass became palpable. Carcinoma was suspected but exploration with a finger in the colostomy was negative, and an X-ray examination showed no deformity. The mass seemed to be situated between the lumen of the gut and the abdominal wall. Finally redness of the skin appeared and the tissues became very tender. Diagnosis of diverticulitis was made, probably with perforation, and operation advised. The gut was exposed for a considerable distance above the colostomy. The wall was hard and infiltrated but there was no free pus present, and no individual diverticulum was recognized. Drainage was established and a good recovery resulted. The patient has remained well since.

CASE VIII—Mr J G, sixty years of age, was admitted to the Lenox Hill Hospital April 28, 1930, complaining of severe pain in the left lower abdomen and constipation. In the left lower quadrant, opposite the anterior superior spine a small, hard, elongated tumor mass was palpable, which was tender to touch. Rectal examination gave the feeling of an indefinite, somewhat smooth, evasive mass, which did not impress as an ulcerating lesion. With a history of recurrent attacks of pain for almost a year, which was so severe that he was unable to stand, with constipation for eight months, and the presence of a mass in the sigmoid region, a diagnosis of a surgical condition was made. He had no temperature but there was leucocytosis of 16,000 white blood cells, with 85 per cent polymorphonuclears. We inclined to the diagnosis of sigmoiditis. X-ray examination showed multiple diverticulæ in the descending colon and the sigmoid. An irregular shadow suggesting a cavity connecting with the sigmoid was noted and was interpreted as a rupture of a diverticulum (Fig 4).

At operation there was no free fluid. An inflamed sigmoid was found bound down in the iliac fossa. It was carefully separated and a culture made from the bed (later reported negative). After mobilization it was found that about 3 to 4 inches were involved in an acute inflammatory process which had led to marked thickening of the wall. In one place it looked as if a perforation had taken place but it had become plastered over with exudate. Resection was decided on and the first stage of a Mikulicz operation done. The affected portion of gut was removed ten days later. On opening it the lumen was found to be very small, but the mucosa looked normal. The perisigmoid tissue and the wall itself were very thick and infiltrated. Several incisions were made into this tissue and cultures taken. Pressure on the wall caused exudation



# TREATMENT OF MEGALOCOLON BY SYMPATHECTOMY

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A STUDY of the clinical cases of megalocolon shows the fact that this condition is not because of atonia or lack of power and development of the musculature of the colon. Cameron<sup>1</sup> among others, has described the anatomic condition of the wall of the large gut, the increase in hypertrophy of the longitudinal and to a greater extent the circular muscle fibres. It is observed also that the dilatation of the colon is always greater on the left side. In some cases, indeed, it is present only in the descending limb of the large intestine. In those cases where local excisions have been done of an enlarged loop of bowel, the commonest sequence is to have an enlargement form in the bowel replacing the loop. In one case I reported<sup>2</sup> the patient had had three operations, at each one of which loops of dilated large intestine were removed. This experience has been the not uncommon one following operations at which part or all of the large intestine has been removed for the cure of megalocolon.<sup>3</sup> One is, therefore, justified in concluding that operative procedures of this type do not cure the condition, and in addition it is obvious that the factor producing the dilatation is left still in existence. Its causative factor, therefore, cannot be something inherent in the wall of the dilated bowel. It would appear from this that the condition is really one of obstruction, not complete and constant but incomplete and intermittent. Clinically this has been observed.

Brennemann<sup>4</sup> and David<sup>5</sup> describe the condition associated with congenital strictures of the rectum.

Fullerton<sup>6</sup> believes that the pelvi-rectal sphincter is the factor in producing obstruction and quotes Hurst and the theory Hurst advanced of achalasia, that is, an absence of the normal relaxation of sphincters, in this case the pelvi-rectal or anal sphincter. Sphincter spasms are known elsewhere as in cardiospasm and pylorospasm, and Fraser<sup>7</sup> describes the condition as due to a neuromuscular error resulting in "an uncontrolled function, a delay in acquisition of the power of inhibition combined, it may be, with achalasia and insufficient relaxation of the associated sphincters."

A case herein reported shows the progressive enlargement of the colon in the time he was one and one-half to two and one-half years of age. During this time the capacity of the colon was much increased, as is shown in Fig. 1.

Hirschsprung's disease is described as a congenital dilatation of the colon, but if such a condition exists it must be very rare, as most of the cases that are followed closely are found to be of the type that are obstructive in origin. It is true that the majority of the cases of megalocolon that are

The procedure that we have followed has been to attack the lumbar sympathetics from the lumbar approach, and we have recently removed the whole trunk from the second down to the level of the fourth. This has produced in patients, in addition to the changes in lower bowel function, two grateful changes, *vis*, warm feet and dry feet, and no deleterious effects have yet been manifest from this proceeding. The operation of the approach through the flank, as recommended by Royle, is readily done and is undoubtedly rendered more easy by the use of spinal anæsthesia. After the flank incision the peritoneum is pushed forward and the sympathetic cord is readily felt lying on the anterior aspect of the lumbar bodies. In one case only of megalocolon have we done a bilateral operation, but in lumbar sympathectomies for vascular diseases of the extremities many cases of



FIG 2—M F K, 1931 X-rays of barium enema September 1927—March, 1931

bilateral operation have been done at the one visit to the operating room. The operation is, strangely, devoid of shock.

I have recorded the details of three cases of megalocolon treated by ramisection and ganglionectomy.<sup>2</sup> These three cases have continued well. One case operated upon in 1927 is having a normal bowel-movement history (Fig 2) (M F K, February, 1931). Another case, operated upon in 1929, had a relapse from the normal, but she was a child who came from a home that was altogether disorganized, the father in jail and the mother irresponsible. After a "clean-out" she is, however, having again normal movements. The third case, of a woman of thirty, who had, previous to double lumbar ganglectomy, had an appendectomy and three local excisions, reports after the experience of sixteen months no difficulty with movements. The volumetric change in the enema she could tolerate changed from 120 ounces to fill the sigmoid and ascending colon before operation, to 80 ounces to fill the entire colon two months after operation. This case showed a marked improvement in the haustra of the cæcum, and the right side was operated upon.

Three additional cases are here reported in detail.

half to one hour later Cries as if in pain, pulls hands and feet up Magnesia caused small watery movement Since the beginning, July, 1927, the fecal discharges have always been well formed Hard at first, now slightly softer This has persisted throughout *Mucus* Recently, last two months, comes before movement Greenish tint, small amount *Color*—Changeable, occasionally very dark green, almost black Sometimes clay color, exceptional *Odor*—Very foul-smelling always Has undigested food in stool sometimes Mother claims that child masticates food thoroughly Lasted first few weeks of constipation only Child otherwise has been very healthy *Sleeps*—Well for last eight months, at first restless and irritable *Appetite*—Very poor *Bowels*—Constipated *Pains*—Over abdomen, irregular Cries a lot with them Occur with a movement Also very irritable

The patient is a well-developed, well-nourished boy, not actually ill Tongue coated Buccal mucous membrane is clear Teeth in fair condition Tonsils are small and cryptic Pharynx is not congested Abdomen is full, rounded and soft Colon is palpable the whole distance from the right lower quadrant down to the sigmoid It contains a large amount of fecal matter, particularly the sigmoid, which is palpable in a large moveable mass in the pelvis The colon does not appear to be dilated and



FIG 4—B F Two on one slide July 10, 1930 September 15 1930

is about normal in size Transverse is above the umbilicus and not apparently displaced It can be observed to move with respiration Liver, kidneys and spleen are not palpable No other masses No tenderness No meningeal signs No apparent motor or sensory defects Intelligence apparently normal *Diagnosis*—Hirschsprung's disease

After being in hospital two weeks he was sent home to have medical treatment, July 6, 1930 Again admitted to hospital Has not improved since leaving the hospital

*Special Examination*—Abdomen Abdomen is distended in appearance, but moves freely on respiration The note on percussion in the upper part is resonant, the lower part shows dullness There are masses felt in the lower portion of the abdomen These masses can be indented and are putty-like in consistency By rectal examination large masses could be felt in the lower bowel which were fairly firm in consistency but of putty-like consistency

*Operation*—July 16, 1930 A left-sided lumbar ganglionectomy through a flank incision

Following this the child had, while in hospital, enemas, but within a month had daily spontaneous movements The colon was materially changed, as evidenced by X-ray of barium enema Haustra were well marked and girth smaller Moreover, the giving of enema caused pain, whereas it was formerly born without discomfort and

is sufficient to produce a resumption of normal habit. These cases, if not carefully supervised by those in charge of them, may develop the bad habit of neglecting to have regular defecation. Yet these are readily returned to a daily habit again. The administration of a barium enema at periods following operation gives ample evidence to the administrator of the reduced size of the colon and the spasm that is easily induced in the colonic wall. Colons that would, prior to operation, tolerate large quantities of enema, some time after operation suffer pain and a desire to expel when only a small quantity is introduced. The diminution in the size of the colon following operation takes some months to become marked. The presence of haustrations is likewise more marked as time elapses. Bowel function may show no marked improvement for some weeks. It is probably advisable to have daily enemas given following operation for the period the patient is in bed. After this period the patient may well be left to have spontaneous movements.

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been used to designate the primary type of lesion, but I agree with Erdmann that "diffuse adenomatosis" is a better and more satisfactory term, and with Broders that "polypoidosis" is a much more descriptive pathologic term. Polyposis, for instance, may mean only two polyps, either sessile or pedunculated, or any number of polyps of the colon. Polypoidosis, on the other hand, indicates that the entire lumen of the large bowel, from the anus to the cæcum, is studded with projections which raise the surface of the intraluminary portion of the bowel, and between which there are small strips of normal mucous membrane giving it the appearance of many convolutions, as in the brain. The secondary lesion is advanced, complicated, chronic ulcerative colitis which, in some of its ramifications, acts as focal infection or produces pseudopolyposis, which is, in itself, a potentially malignant condition, or at least, in my experience, malignancy has occurred simultaneously with it.

Polyps of the large bowel generally have been treated as a single genus of tumor and have been described anatomically as pedunculated or sessile growths, varying in size, shape and consistence, with an underlying papillary or adenomatous structure. Many authors have classified these growths according to some etiologic factor, such as dysentery, ulcerative colitis, hyperplastic tuberculosis, or non-specific affections of the large bowel. Again, the clinical manifestations, particularly as regards diffuse adenomatous types of polyps, have caused them to be classified as of the adult or acquired type, and of the congenital or adolescent type. Unquestionably, the presence of polyps, occasionally single but frequently multiple, in the colon and rectum, is of grave significance in relation to the ultimate development of carcinoma of this organ. Furthermore, polyps occur in the large bowel and rectum four times more often than in other portions of the gastro-intestinal tract. Their presence in the rectum, rendering them particularly accessible to study, and in resected colons, has caused me to undertake evaluation of their relationship to carcinoma, on the basis of histologic study, without regard to the etiologic factor involved.

Anatomically and pathologically, there are two general types of polyps in the colon, one of which is a true neoplasm, the other the result of an inflammatory reaction. One form of the true neoplastic or congenital type of this condition has been designated by Erdman as "diffuse adenomatosis" and I am inclined to think this term, or "polypoidosis," or "polyadenomes en nappe," as Menetrier designated the condition years ago, would be preferable. The other form in the colon, of the congenital type, may be present either as one or two discrete tumors, or as discrete tumors which involve the entire mucosal surface of the bowel from the anal canal to the ileocecal coil, and is, in reality, more of a true neoplastic condition as compared to polyadenomes en nappe or polypoidosis. Both usually occur in families and the former is known to undergo malignant change in from 40 to 50 per cent of the cases. In this form, small, raised elevations of the mucous membrane a few millimetres in diameter may occur, or the elevations may be scattered

are pushed into multi-layered buds which project into the lumens of the tubules, but more often into the connective-tissue matrix. The nuclei are elongated, take stains deeply, and give to the proliferating tissue a darker color. As this epithelial proliferation progresses, there is a complimentary response in the connective tissue of the muscular and submucous coats, which produces a stalk. The pedicles are large or small, according to the rapidity of the proliferation. I feel that the tempo of the development of the carcinoma in polyps is an extremely important factor in their metamorphosis.

In Group 3, the epithelium is almost completely undifferentiated. It is an accentuated form of that seen in Group 2. The development of the epithelial proliferation, which outpaces that of the connective tissue, results in a polyp which is of complex histologic structure. Grossly, the polyps of Group 2 may attain large size and age, whereas those of Group 3 rarely do, becoming early, I believe, deep, infiltrating carcinomas.

This congenital type of polypoidosis, recognized, as it is, as a precursor of malignant growth in a high percentage of cases, is not an exceedingly rare entity. Bagen gives its ratio to the acquired type as approximately 1 to 4. The congenital or adolescent type manifests itself in young persons by profuse rectal hæmorrhage and diarrhœa, associated with concomitant anæmia, and occasionally with acute intestinal obstruction. This disease was first described by Virchow, in 1863, as "colitis polyposa," and Cripps, reviewing three cases which occurred in one family, shed more light on the subject in 1882, when he described accurately the conditions which is designated as polypoidosis. Cripps' first patient, a man aged twenty years, had had symptoms for ten years, and polyps had been removed by way of the rectum with only temporary relief. This patient succumbed suddenly, and post-mortem examination disclosed that death was due to adeno-carcinomatous stricture of the sigmoid, which occurred in the presence of diffuse, pedunculated polyps. Subsequently, Cripps reported two other cases, those of a brother and a sister of the first patient, aged seventeen and sixteen years, respectively.

One patient on whom I performed total colectomy had a sister who died at the age of twenty-eight years with multiple polyps of the bowel, and a brother is now being treated at the clinic for multiple polyps of the bowel, at this time the brother is resting between stages of operation for removal of the entire colon.

Erdmann's two patients were youths aged fourteen and sixteen years. Neimack, I believe, reported the case of the youngest patient on record, that of a girl aged twelve years, who had had symptoms for three years.

The diagnosis of congenital polypoidosis is usually made by digital or proctoscopic examination, because the polyps invade the rectum as well as the entire colon, and are both palpable and visible, even on cursory examination. Röntgenograms, especially those made by the combined method of Fischer, in which an opaque enema is followed by rectal injection of air, are especially accurate in interpretation of the presence and distribution of polyps. Usually the entire bowel is studded with small tumors, interspersed among

This was evidenced chiefly by five or six passages of mucus and fecal material in twenty-four hours, blood was never observed in the passages. Her general condition was good, appetite, digestion, and weight were maintained.

Examination revealed that the patient was asthenic and anemic but gave no evidence of loss of weight. Polyps were noted on digital examination, and on proctoscopic examination the rectum and sigmoid were seen to be studded with polyps. Tissue from one polyp was characteristic of adeno-carcinoma, graded 2. Examinations of stool did not give evidence of ulcerative colitis. Rontgenologic examination demonstrated multiple polyps of the entire colon. The concentration of hæmoglobin was 68 per cent, and erythrocytes numbered 4,480,000.

November 26, 1928, ileostomy was performed, June 20, 1929, partial colectomy was



FIG 2—Polyposis of the colon, showing tendency toward attenuation of cells

performed, the rectal stump being turned in and placed retroperitoneally, and July 3, 1929, the rectal stump was resected posteriorly.

Pathologic examination disclosed multiple polyps throughout the colon and rectum (largest 4 centimetres, near the cæcum) (Figs 1 and 2), one pedunculated polyp in the transverse colon (1 centimetre), one pedunculated hæmorrhagic polyp in the descending colon (1 centimetre), one pedunculated polyp in the sigmoid (3 centimetres), innumerable small polyps, and one adeno-carcinoma, graded 2, involving a polyp in the rectum.

The patient died April 19, 1930, eleven months after the third stage of the operation was completed.

CASE II—A woman, aged twenty-five years, was admitted to the clinic with a history of having had diarrhœa since childhood. Up to three years prior to admission she had had four to five stools daily, but since then had had as many as eight and ten. At first blood appeared in the stool frequently and, more recently, was noted every day and in increasing quantity. Polyps often protruded from the anus. Her general condition,



FIG 4



FIG 5

FIG 4—Single polyp of colon

FIG 5—Carcinoma of sigmoid in a case of multiple polyps of the colon



FIG 6a



FIG 6b

FIG 6a—Polyps obscured by barium filled colon

FIG 6b—Rontgenogram of colon by Weber's modification of Fischer's method showing sessile polyp in descending colon and pedunculated polyp in distal part of transverse colon



peritonitis was not a formidable objection. The already existing immunization unquestionably was of great advantage in these cases, and although, in the first colectomy in this series, I broke into an abscess in the glands around the cæcum, there was little reaction following the operation and the patient made an uninterrupted recovery.

Besides the unhappy sequel of long-standing chronic ulcerative colitis, resulting in complications, the superimposition of malignant disease on the polyposis which is secondary to the colitis is important. That this is not unique, although it does happen infrequently, is attested by the fact that in more than 1,100 cases of ulcerative colitis, complicated and uncomplicated, seen at The Mayo Clinic, in twenty-five cases carcinoma has developed in the presence of the polyposis which was caused by the inflammatory lesion. Although perhaps it is impossible to prove pathologically that these carcinomas developed as direct sequelæ of events of the inflammatory process, I think it is a reasonable conclusion that if chronic irritation of long standing initiates carcinomatous changes in a viscus, complicated, progressive, ulcerative colitis of long standing is a factor in malignancy.

The production of multiple polyps as a sequel of chronic ulcerative colitis has been explained by numerous authors as resulting from undermined ulcers which produce a break in mucosal continuity, leaving an overhanging portion, which, being shut off by the regenerative process, forms a pedunculated, polyp-like tumor, with smooth or irregular marginal outlines. The elevations thus formed are surrounded by regenerating mucosa, and, as healing takes place, contraction no doubt leads to their further elevation. The same process isolates the polyps and not infrequently closes the glandular orifices, forming retention cysts. When the polyps become pedunculated the formation of the pedicle is, I believe, the result of the tug on the loose, underlying tissues by the peristaltic action of the bowel, thus producing a true polyp.

Hewitt and Howard, Struthers, and others, in considering the development of polyps resulting from inflammatory lesions, particularly ulcerative colitis, have stressed the importance of good blood supply, which causes the mucosa to be preserved and hastens the hyperplasia and regeneration of glands around the ulcerative processes. I have not been impressed in my cases with the fact that the polyps are found nearest the principal blood supply of the bowel. In all three cases which followed ulcerative colitis, I have demonstrated formation of polyps so diffuse, as to cover the entire intraluminary mucosa of the bowel. The idea of Ewing, Erdmann, and others, that these polyps may be followed through the transitional steps, from thickening and hyperplasia to adeno-carcinoma, is likewise, I believe, a possibility, the actual proof of which is more difficult to procure than in the congenital variety.

The following three cases of multiple polyps, scattered diffusely throughout the large bowel, secondary to chronic ulcerative colitis, are illustrative

months was able to go home. He came to the clinic again, September 22, 1926. He stated that he had gained thirty-seven pounds in the four preceding months and that he was having six to seven movements of the bowels in twenty-four hours, which only occasionally contained a little blood and mucus. The rectal mucosa contained a few pitted scars and slightly pale. There were many polyps, from 0.3 to 0.7 millimetres in diameter, and from 0.3 to 1.5 centimetres in length, some of them bled easily. The diagnosis was made of polypoidosis following healing in an extremely advanced case of chronic ulcerative colitis. Clinically, the patient was in excellent condition. He was dismissed with instructions to take vaccine subcutaneously. He returned May 23, 1927, clinically well, stating that he had had the best winter since the beginning of his illness. He had gained fifty pounds and looked the picture of health. He had had an average of three bowel movements daily for months and had not seen blood in the stools for at least a month. At this time proctoscopic examination disclosed the signs of healing after chronic ulcerative colitis, polypoid areas, and polyps. The small polyps, seen January 23, 1927, had disappeared. The mucosa between polyps was normal except



FIG 9



FIG 10

FIG 9—Acute colitis with ulceration and desquamation on a basis of chronic ulcerative colitis.

FIG 10—Chronic ulcerative colitis, partial destruction of mucosa with some evidence of healing.

for the scars of the infection. A series of fulgurations of rectal polyps was carried out without incident. The patient was then free of symptoms of all intestinal trouble, but because it had not been possible to fulgurate all the polyps at this first visit, he returned in December, 1927 at which time proctoscopic examination revealed that there were still several polyps in the rectum, but that the mucosa was in good condition. The polyps were again fulgurated.

August 9, 1928, the patient returned for observation and scars were noted in the rectum, but there was no ulceration. The lumen was practically normal in diameter. There were no polyps in the areas that had been fulgurated. A month later he returned with rapidly growing nodular lesions on the right arm. Surgical excision revealed hemangio-endothelioma. Treatment with radium and Rontgen-rays followed. There was no evidence of recurrence. During the severe exacerbation of colitis in 1926 the patient had suffered months of disability from what was designated peripheral neuritis. He had, at that time, constant burning pain in the balls of the feet, and later higher in the legs, so that he could not allow bed clothes to touch his feet. Anaesthesia and muscular weakness were present. Recovery from the colitis was accompanied by recovery from the neuritis.

From May, 1927, until January, 1929, the patient was free of intestinal symptoms. About January 1, 1929, he had severe influenza, and after three weeks of this illness an exacerbation of the colitis occurred. Treatment was again instituted and gradual improvement resulted. In June, 1929 polyps were again seen through the proctoscope, some of which were large and firm. Operation was decided on because of the exacerbation of the colitis and the potential danger of malignant change in the polyps. October 15, 1929, ileostomy was performed. April 15, 1930 partial colectomy to a point near the rectosigmoid juncture was performed and October 14, 1930, combined abdominoperineal removal of the rectal stump was carried out. The patient had gained forty pounds since colectomy.

The pathologist reported diffuse inflammatory polypoid hyperplasia of the mucosa of the colon associated with acute colitis accompanied by ulceration and desquamation on a basis of chronic ulcerative colitis (Figs 9 and 10).



FIG 13—Chronic ulcerative colitis with evidences of healing

Recovery was uneventful and the patient is now attending college.

CASE V—A woman, aged twenty-three years, was admitted to the clinic first in December, 1918, with a history of watery diarrhoea occasionally accompanied by passage of blood for two and a half years. At first there were only three or four daily rectal discharges, but the condition became progressively worse, so that on admission the number of movements had increased to eight or ten a day, and there was some abdominal cramping. During this period the patient lost twenty-nine pounds. A diagnosis of chronic ulcerative colitis was made by proctoscope and roentgenogram (Fig 11).

The patient failed to improve under a medical care which was tried three months, so ileosigmoidostomy was performed February

19, 1919. At the same time, the divided distal end of the ileum, and the proximal end of the sigmoid were brought out through the abdominal wound in order that the colon, thus excluded, could be irrigated. Although there was some abatement of symptoms during the next year, the patient was still disabled. Subtotal colectomy was therefore performed (Figs 12 and 13.) Improvement following the procedure was transient, due to the development of severe proctitis, with formation of stricture at the site of the anastomosis, accompanied by diarrhoea and considerable abdominal pain. All medical measures, including numerous injections of polyvalent dysentery serum, failed to cause benefit. Ileostomy was therefore performed January 21, 1925, and May 29, 1929, the rectal stump and remaining portion of sigmoid were removed by combined abdominoperineal operation. The patient made a satisfactory recovery from the operation, and, in spite of subsequent pulmonary hæmorrhages, associated with active tuberculosis, she maintains her normal weight and now leads an active life.

CASE VI—A woman, aged twenty-seven years, came to the clinic first in June, 1924, with a history of bloody dysentery of one year's duration. The trouble began

October 24, 1930, combined abdominoperineal removal of the rectal stump were performed

The pathologic report was hemorrhagic ulcerative colitis with marked narrowing of the lumen and thickened walls (Figs 15 and 16)

The patient has made a satisfactory recovery and has returned to her occupation as stenographer

#### TECHNIC



FIG 15—Hemorrhagic, ulcerative colitis, marked narrowing of lumen thickened walls

In extirpation of the entire colon, two procedures are available (1) Operation in three stages, consisting of ileostomy, colectomy including the colon down to the rectosigmoid junction, and combined abdominoperineal resection of the rectum, and (2) ileosigmoidostomy followed by colectomy. The latter method frequently leaves a rectum and sigmoid covered with polyps which must be treated by fulguration or other local destructive measures. It has the great advantage, however, of retaining the splendid sphincteric apparatus provided by nature and avoiding the necessity of making an abdominal anus. On the other hand, one is more likely to be compelled to remove the rectum at a subsequent stage after ileostomy and colectomy because of the presence of large and multiple polyps in it, rendering fulguration of uncertain value. Between the two operations one may vacillate, remembering, however, that after ileostomy and colectomy, if it is possible to get rid of the rectal polyps, a feasible step is to implant the ileum into the top of the rectum at a subsequent manœuvre.

In the six cases outlined, total colectomy was done in three stages. Ileostomy was the primary manœuvre and colectomy including the colon down to the rectosigmoid the secondary manœuvre, the third stage consisted of combined abdominoperineal resection of the rectum. Obviously, one should not attempt ileostomy and resection of the colon in a single stage. Ileostomy of itself is a serious procedure because of the disturbance of water balance which follows it. Most of the fluids are absorbed in the right portion of the colon, and to divert the fecal current by ileostomy is to cause such rapid loss of fluid that the patient invariably loses weight and is dehydrated until such time as reestablishment of the physiologic equilibrium takes place. At that time, the ileum begins to assume the function of the right portion of the colon, and the stools become semi-solid or formed.

one of the steps, I have shut off the space between the mesentery of the terminal portion of the ileum and the lateral parietal peritoneum, just as one would do in performing colostomy involving the sigmoid. This prevents obstruction by loops of small bowel slipping around the structures formed at ileostomy and becoming adherent. Since the ileostomy is made through a small McBurney incision, without exploration, and the wound heals tight a single-barreled stoma results, which is not difficult to care for (Fig 18).

I have found it advantageous to postpone the second stage of the resection for about three months. During this time the patient accommodates himself to the presence of the stoma, gains in weight, the stool becomes semi-solid or formed, and the general condition is much more favorable for a



FIG 18—After completion of ileostomy

formidable resection than formerly. At the second stage the colon is removed through a long left rectus incision. The dissection begins in the right side of the colon, at the cæcum (Fig 19), and the mobilization is made by dividing the outer leaf of peritoneum, just as one does in resection for carcinoma. The operation may be performed in a much less radical way than for carcinoma, dividing the vessels of the mesentery close to the wall of the bowel, and leaving adequate peritoneum to cover over raw spaces. After the right portion of the colon has been mobilized, guarding against injury to the ureter and retroperitoneal portion of the duodenum, and the vessels are secured and peritonization completed, the dissection is carried along the under-surface of the omentum (Fig 20). That structure is left, but the transverse colon is readily mobilized around to the splenic flexure.

Mobilization of the splenic flexure is the most difficult step in this manœuvre. It is higher than usual and is more likely to be fixed, but by dividing the splenicocolic ligament one can readily clamp off its vessels and proceed downward with the mobilization of the descending colon and sigmoid (Fig 21). The left parietal peritoneal leaflet is divided similarly to the right, these two segments of the bowel are loosened, the blood-vessels clamped out and tied, and the raw surfaces peritonized. I think it is wiser to divide the bowel at about the middle of the sigmoid or at the juncture of the lower and middle thirds of the sigmoid, so as to be sure of adequate vascularization of the end that is to be left in (Fig 22). When colectomy is to be done

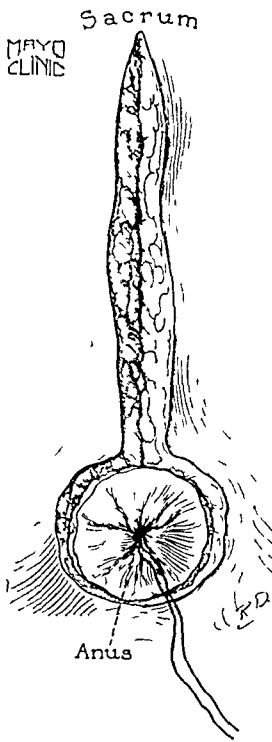


FIG 23—Posterior incision for removal of segment of bowel left after partial colectomy

for polypoidosis, it is a simple matter to select a point with good blood supply, dividing the bowel between clamps, with cautery, and turning in the lower end, with satisfactory knowledge that there will be small chance of leakage, formation of abscess or other complications. In ulcerative colitis, however, it is impossible to turn in the lower end with a suture, as anyone who has attempted it will readily recognize.

In the first case in which I performed total colectomy for polyposis secondary to ulcerative colitis, when the operation was completed down to the point of division of the bowel, a clamp was put across the bowel and closed, with the result that it cut through the entire intestinal wall, leaving a wide-open colon staring out of the peritoneal cavity. With this experience in mind, it has been my custom to divide the bowel, holding the lower end very lightly, and then suturing over and over, without attempting to turn it out, finally, wrapping it in iodoform gauze and bringing it out through the lower end of the wound. Drainage is instituted, and, fortunately, in these cases of colitis immunization is so satisfactory and complete that chances of peritonitis subsequently are less than in the congenital type of polyposis, in which patients have not had the opportunity of manufacturing their own antibodies.

The third stage of the operation is undertaken subsequently, after adequate rehabilitation which may extend over varying lengths of time for different patients. Certainly, I would not undertake it before two to three months had elapsed in any case, and if the patient were badly debilitated it could be put off longer. This stage of the operation is, in complicated cases, the most difficult of the three steps. Particularly is this true in cases of ulcerative colitis in which formation of abscess or fistulas has been one of the reasons for undertaking the total colectomy. I have been accustomed to doing this third stage after the method of combined abdominoperineal resection of the rectum, starting from behind (Fig 23), mobilizing the rec-

quickly some of these large cavities will close and contract down to a small drainage tract which, after several weeks, entirely disappears. One patient who underwent combined abdominoperineal resection of the rectum I dismissed on the nineteenth day with a draining sinus which was comparatively small, but the usual patient ordinarily takes about four weeks in the hospital after this stage of the operation.

Rehabilitation after these formidable procedures is slow and adequate dietary measures and other steps for increasing the patient's resistance are

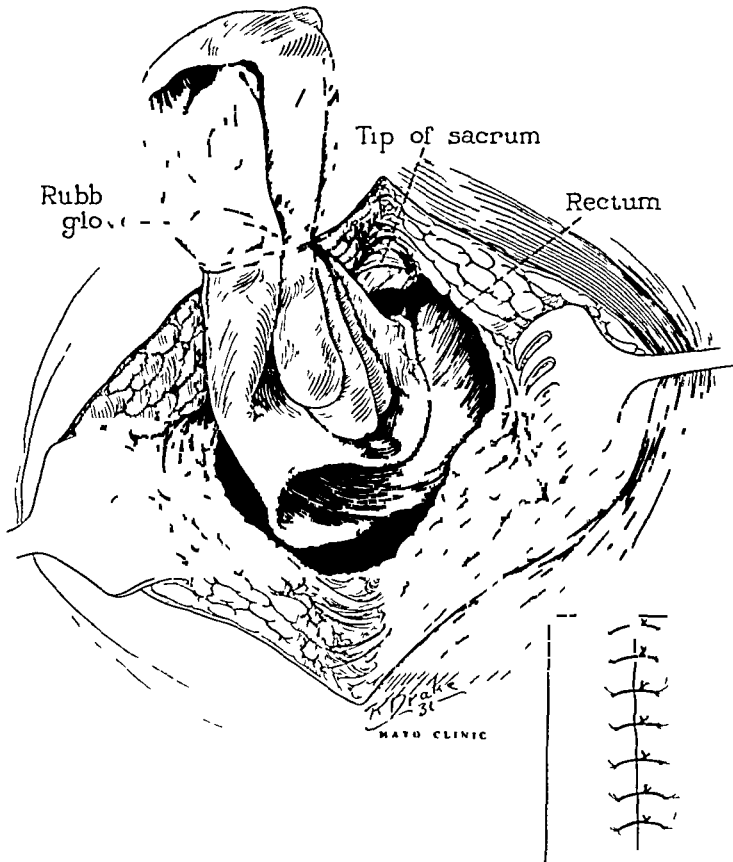


FIG. 25.—Completely mobilized rectum encased in rubber glove. Insert shows wound closed after segment is dropped back into hollow of sacrum.

urgently indicated. The immediate post-operative care of these patients, following the third step, is similar to that following any combined abdominoperineal resection.

In this series of six cases there has not been a death from operation.

I particularly want to call attention to the advantages of graded removal of the large bowel and rectum when its extirpation is necessary, and to emphasize the thought that polypoidosis, and particularly the congenital variety, is a potentially malignant condition which warrants radical measures before metamorphosis into carcinoma has taken place. As for the other indication for resection, complicated chronic ulcerative colitis, it is evident that the

She had ulcers, and Doctor Lund hoped, as had been in other cases, that putting the colon at rest would cure this ulcerated colitis, but the ulcers never healed. Although she had bloody stools and mucus for nine years, she kept very well and did all her housework. One day she turned up with a very large abdominal tumor in the upper left quadrant. She had grown very thin, her red blood count was down to just a little above two million. He supposed that she had developed a carcinoma. He did an exploration and found that there was a tremendously inflamed colon and the tumor was the inflamed, swollen, thickened omentum. With a transfusion before and after the operation it was easy to remove that colon. She recovered and has since done very well.

As to Doctor Eggers' observations on diverticulitis, the speaker was of the opinion that whenever one finds a left-sided appendicitis in a fat man of about forty, which feels like a

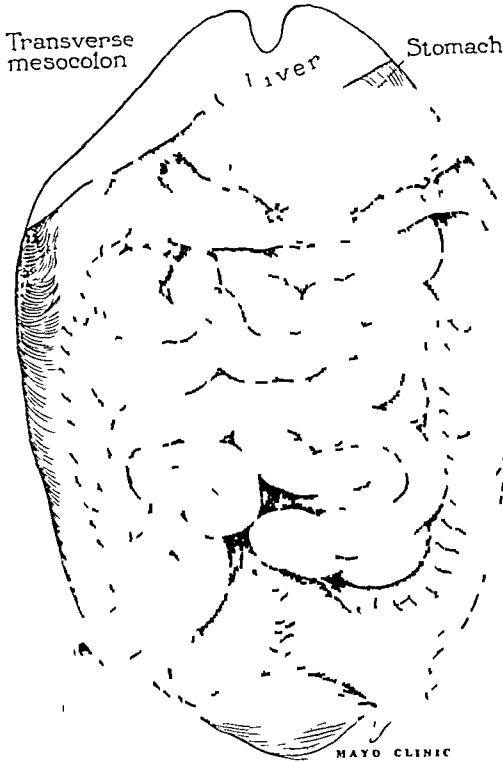


FIG. 29.—Total colectomy completed. The raw surfaces left by dissection are closed with a running suture. A new pelvic floor has been made out of peritoneum.

tumor, one can be sure it is a diverticulitis. In rare cases of appendicitis where the tenderness is on the left, the appendix goes down to the bottom of the pelvis, or the tenderness on the left may be due to inflammation or obstruction making the external coils of the ileum distend. But one can generally tell these diverticulitis cases. He recalled the case of a woman who had an abscess about the size of a pigeon's egg between the layers of the mesentery of the sigmoid. That was drained. The abscess worked down into the pelvis, where it was drained through the rectum. But it never seemed to be drained sufficiently, and after eight months of watching that woman fade away she died.

Another case shows what can be done in severe cases of diverticulitis by multiple operations. This was a very fat old woman of sixty-five, with an acute intestinal obstruction, which was much distended, in which immediate operation had to be done. A left-sided incision was made and an enormous sigmoid was brought out. The intestine was opened above it. The next day feces poured out, and here was this great mass on the outside of the abdomen. But it did not

feel like a carcinoma, it was pretty smooth. A week or ten days later that was cut off according to the Mikulicz procedure and an enormous amount of pus came out from between the layers of the mesocolon and also around it. If one hadn't waited until that was walled off one would have lost the patient. Her heart went on all right, although she had an intermittent pulse, and the clamp was put on. Subsequently, without ever opening the peritoneum again that whole thing quieted down and it was possible to suture the bowel. It held, and she went home in excellent condition, with her heart better than it had even been for years.

Suppuration between the layers of the mesosigmoid is one of the worst things which may happen in these cases of diverticulitis, and it has been his experience that when the abscess has been opened, they subsequently come to a resection. In cases where there is a multiple diverticulitis, but only one section is inflamed, one can disregard all the area that is not inflamed and resect the inflamed area as if it were a carcinoma, and they get well.



Doctor Horsley uses the basting-stitch technic of Doctor Kerr. It is ingenious and attractive, and in many cases it has worked out well. In two of his patients, however, it was not satisfactory and mortality resulted. The objections to this basting-stitch technic are these: (1) In placing the basting stitch it is sometimes difficult not to penetrate the bowel. If the bowel is penetrated the stitch is infected, and when it is pulled out it spreads the infection along the track of the stitch and in the peritoneum. Even when carefully inserted there is sometimes eversion of the mucosa. (2) Occasionally the stitch hangs and it is difficult to remove. This traction on the basting stitch may disarrange the permanent sutures. In one case he found it necessary to open the bowel in order to remove the basting suture, and the patient died. (3) A large amount of diaphragm is turned in, so obstructing the lumen. This consists not only in the amount of tissue already turned in by the basting stitch, but in the tissue between the basting stitch and the permanent suture, even assuming that only one row of permanent sutures is used. Unless the calibre of the bowel is large this diaphragm may produce complete obstruction, and while such obstruction may be overcome in experimental animals such as dogs with strong intestinal muscles it is of serious consequence in man, as he knows from personal experience of a fatal case. (4) The mucosa in the basting-stitch technic is not accurately approximated. While this is of no particular consequence in a small bowel whose contour is smooth when there is a small amount of diaphragm, in the large bowel where the contour is irregular and when a deep diaphragm is turned in by the basting stitch the fecal matter may lodge in between the mucosa of the two ends of the bowel and cause trouble. A narrow, firm line of apposition of the whole bowel wall (as often observed after the Murphy button) gives the most desirable eventual results.

If the colon is drained for at least ten days before the resection by a complete enterostomy opening, the resection can be done with almost as much safety in the colon as in the upper small intestine under ordinary conditions. The mucosa and the whole bowel wall are sutured with linen or silk from *within* as far as possible, this including the mesenteric portion, and then the remaining portion can be whipped over from without if necessary, tying the suture to the original end. Over this is placed a series of interrupted mattress sutures of catgut, and after tying them the ends should be passed through some adjacent peritoneal covered fat, such as the omentum. The enterostomy should not be closed for at least ten days after the resection.

DR W E SISTRUNK (Dallas, Tex.) said that he had always felt, in the work he had done, that the high mortality which came from operations on the colon came, in many instances, from the effort to accomplish in one operation something which really should be divided into several different stages. A great many patients have been lost through failure to appreciate that a patient can stand so much and no more, and that if one does try to divide operations into stages, although a good deal of time is lost to the patient, that many times the patient may be sent home well instead of the wrong way.

He had always felt in resecting the ascending colon that he obtained better results by carefully preparing his patients beforehand, in order to get the bowel as empty as possible, then through a left incision by making an ileocolostomy. This ileocolostomy allows drainage below the loop which may be partly obstructed and puts it, to a great extent, at rest. This does away, to a great extent, with the acute infection which surrounds practically all carcinomas of the bowel.

After a period of two or three weeks has passed, and the patient is up and about, one can go back to a perfectly clean incision on the right side and resect the bowel, after it has been mobilized, and then have nothing to do but close off the two ends of the bowel, the ilium end and the end of the transverse colon, and the operation is completed. Many times this can be done without any draining, and only a delay of two or three weeks is occasioned by this step.

to the sigmoid, which apparently was adherent to the top of the bladder. He reopened her. Although the entire sigmoid had been removed, he found little bunches of fat running up the ileum for about six or eight inches and one of these had become adherent to the bladder and produced the kink. The release of that immediately gave her complete relief.

DR HARRY H KERR (Washington, D C) differed from Doctor Horsley as to the disadvantages, or the weakness, of the basting stitch.

The question of turning in too much bowel depends upon three factors. How much has been crushed in the clamp, how far the basting stitch is taken from the clamp, and how far the anastomosing stitch is placed from the basting stitch.

In the large bowel the amount of invagination is not of as great importance as in the small bowel. In the small bowel, the higher you go the more the partial diaphragm interferes with the lumen of the bowel and the greater the danger of obstruction. In operating on children, or the small bowel of adults, we divide the bowel at an angle to its axis. If it is divided at an angle of 45 degrees, the circumference of the stoma is twice the circumference of the bowel and the danger from invagination disappears.

If one uses a single anastomosing suture one reduces the amount of the invagination. The question of the amount of invagination is easily controlled and should never cause obstruction. By the use of a single anastomosing suture the amount of invagination is materially reduced.

As to the difficulty from breaking the basting stitch in my earlier experience, I had a basting stitch break but I now use stout Pagenstecher linen. Stout waxed Pagenstecher linen, I think, should be used.

As to the possible advantage of suturing the mucous membrane, he does not believe that holds because he does not believe you can suture the mucous membrane and get primary union. We all know that intestinal union is not by the healing of like tissues but by the agglutination of the peritoneum that subsequently becomes organized.

a mortality of 42·8 per cent. Two of the patients who died had extensive metastases, one of whom developed peritonitis and ileus, but apparently rather from handling the infected neoplastic bowel wall than from a leaking anastomosis, which could not be demonstrated. The third fatality occurred from cardiac failure in 24°. In addition to these preferred methods, there was one instance of successful resection of the hepatic flexure followed by side-to-side ascending-transverse colostomy with simultaneous cæcostomy, and one successful case of end-to-end anastomosis of ileum to transverse colon—made easy by the great distention of the former. The fifth fatality in this right-colon group was due to shock and peritonitis following an emergency Mikulicz procedure made between limbs of the ileum and transverse colon necessitated by the collapse of the patient on the operating table. In one of the successful end-to-side anastomoses in a patient with extensive hepatic metastases a simultaneous ileostomy was done. The average period of hospitalization of patients upon whom successful right colectomy was done was 22·3 days. The analysis of the records of this group does not suggest that any of the five fatalities could have been avoided by a provisional ileostomy. Four of the patients showed extensive metastases and one had chronic cardiac disease, and in the one instance where peritonitis was a factor no leak could be demonstrated at autopsy. The conclusion seems justified that the best method of handling carcinoma of the right colon is by resection of the entire right colon, with end-to-side anastomosis of ileum to transverse colon, without preliminary or simultaneous ileostomy. It is possible that in selected cases a fractional method in stages as suggested by Goetsch might be useful.

In the transverse colon we are dealing with a portion of the bowel which is mobile, entirely covered by peritoneum except for the omental attachment, possessed of a good but not rich blood supply, and containing semi-fluid or pultaceous fecal contents, which may become inspissated and lumpy in the presence of marked stasis. Obstruction is not common, partly because the faecal stream is fluid enough to pass through a small opening, and partly because the superficial position of this portion of the bowel makes it likely that the tumor will be noticed by the patient or his physician before the symptoms are advanced. The bowel being mobile by virtue of its long mesentery, resection can be carried out without great difficulty—on the other hand, these tumors seem to be peculiarly liable to involve the greater curvature of the stomach and to a less extent adjacent coils of intestine. The problem here is to decide whether a primary resection shall be carried out, and if so, by suture anastomosis or by the Mikulicz procedure, and whether by either method there should be a simultaneous proximal safety-valve cæcostomy or colostomy, or a preliminary one made some days before the resection.

The advantages and disadvantages of some of these methods must be carefully considered. With most authorities a cæcostomy is the ideal form of temporary safety-valve. Among its advantages are that it is certain to be proximal to any colonic lesion even if the exact situation of the latter is not known, the location of the cæcum is very constant and the operation

liability of the ends to retract as late as seventy-two hours, and states that in 183 cases at the Mayo Clinic the mortality was 9.6 per cent to which must be added 7 per cent of recurrences in the abdominal wall. He says that general statements as to its mortality and end-results are not confirmed by studying a group of cases. He finds useful application of the method in a few selected cases. Gehrels<sup>8</sup> states that the Mikulicz procedure seems to have the lowest mortality and advocates a modification which avoids the "unsurgical" crushing of the spur which may lead to pain, hæmorrhage, stenosis and peritonitis, and substitutes a painstaking freeing of the double-barrel colostomy several weeks after the resection, with end-to-end suture, not hesitating to enter the peritoneal cavity. Gordon-Taylor<sup>5</sup> asserts that the Mikulicz type of procedure has the lowest mortality but advises a preliminary cæcostomy of a type to divert entirely the fæcal current, which would seem to imply that one of the chief advantages claimed for the Mikulicz method—free drainage of the bowel from the proximal opening of the double-barrel, is in fact, negligible. Sistrunk,<sup>9</sup> considers the operation as the safest method in certain cases of carcinoma in the mobile portion of the colon, but the contraindications which he gives limit its employment to a few cases, for he says it is unsuitable for adherent growths with infection of the bowel wall and adjacent tissues, for large growths associated with infection, for obstructing lesions, and for growths in the sigmoid in obese patients with short mesenteries. He recommends for some of these cases a modified procedure preceded by a transverse colostomy. Richardson,<sup>10</sup> Bolling,<sup>11</sup> Lockhart-Mumme,<sup>12</sup> de Martel<sup>13</sup>, all advocate a modified Mikulicz-type procedure in certain cases, on the other hand, Grey-Turner<sup>14</sup> apparently gives the method no consideration.

The alternative to an operation of the Mikulicz type is resection of the lesion, with immediate anastomosis by either simple suture or by one of the two-score-odd aseptic methods, which as Rankin says, have been described, either as a complete operation, or accompanied or preceded by some form of temporary intestinal drainage. The experience at the Peter Bent Brigham Hospital is offered as an aid to understanding and solving these disputed points.

Eleven resections of the transverse colon have been made with two deaths—a mortality of 18.1 per cent. Nine of these resections were made by direct suture anastomosis, end-to-end—of these eight recovered and one died, two were made by the Mikulicz method, of whom one recovered and one died. Among the eight successful suture anastomoses three had a preliminary safety-valve cæcostomy and five did not, the hospitalization of these patients averaged 31.2 days. The one fatality was due to adhesions of the small intestine to the suture line, with kinking and obstruction, this patient had had a preliminary cæcostomy, and inasmuch as the adhesions were presumably due either to local infection at the time the anastomosis was made, or to subsequent slight leakage, it may be argued that if a proximal colostomy of complete type could have been made, to divert completely the fæcal current and permit cleansing

the distal colon made by suture anastomosis remained in the hospital an average of 43·3 days, the thirteen successful Mikulicz cases stayed an average of fifty-three days. Among the suture-anastomosis cases 50 per cent were completely healed on discharge and 27·2 per cent had a fæcal fistula, (the remainder had granulating wounds or sinuses), whereas among the Mikulicz cases only 30·7 per cent were completely healed on discharge and 53·8 per cent had a fæcal fistula. As giving some evidence of the comparative general character of these groups, it may be added that 63·6 per cent of the suture-anastomosis patients were completely obstructed on admission, contrasted with 46·1 per cent of the Mikulicz cases. If the distal colon and transverse-colon cases were combined, constituting a larger group where both the suture-anastomosis or Mikulicz procedure are applicable, the evidence appears to be even more in favor of the former. The average hospitalization of the suture group is forty days, that of the Mikulicz series is fifty-six days, the incidence of fæcal fistula is 20 per cent for the suture cases and 57·1 per cent for the Mikulicz, the mortality is 14·2 per cent compared with 22·2 per cent. In further comparison of these two methods the reviewer of the hospital records cannot fail to be struck by the frequent mention among the Mikulicz cases of pain occasioned by the application of clamps, the necessity of re-application of clamps, and the annoying infection of the wounds. In some confirmation of the general impression of the fallacy of statistics it may be mentioned that in the early days of the hospital four resections were done by the original Mikulicz method with good recoveries and average final results.

A question which has been of especial interest to the writer for some years is that of the relative efficacy of a cæcostomy or colostomy of temporary type made with a tube which necessarily diverts only a part of the fæcal current and acts as a safety-valve to prevent gaseous distention, and a proximal colostomy of permanent type which completely diverts the bowel contents. In theory, the former is easier to make, gives sufficient escape of the fæcal current to safeguard the anastomosis and will close spontaneously, while the latter is harder to make, is unnecessarily complete in its function and always requires formal operative closure. The writer believes that all but the last of these assertions are frequently untrue, and that the permanent type colostomy as a preliminary to all resections with suture-anastomosis of tumors of the colon distal to the mid-point of the transverse colon is the operation of choice. In this viewpoint he is probably greatly in the minority since most surgeons perform the temporary cæcostomy or colostomy as a matter of course. Pfeiffer and Smyth,<sup>15</sup> however, and Judd<sup>2</sup> advocate complete diversion of the fæcal stream and irrigation of the distal colon to cleanse it before resection, and Gordon-Taylor<sup>5</sup> has already been quoted as doing a complete cæcostomy. Rankin<sup>7</sup> states that operative closure of a colostomy is a much more formidable procedure than of a cæcostomy. For some years the writer has practised the permanent type colostomy in suitable cases as

delicate white linear cicatrix which has formed at the edge of the incision in the bowel wall and which now tends to constrict and maintain it in eversion is carefully dissected off, the mucosa can be readily turned in and a surprisingly small opening remains to be closed by a two-layer catgut suture. A folded bit of protective tissue should be carried down just through the aponeurosis, and the wound otherwise closed in layers.

The scrutiny of this group of cases of resection of the colon for carcinoma has gone far toward confirming opinions which have gradually crystallized in the writer's mind and which for some years he has been adopting in practice. The particular doctrine which he wishes to support and which seems to him to be justified by the experience quoted above, is that a colostomy of permanent type, made as a preliminary or first-stage operation in resection of the distal colon, and later closed when its work is accomplished, is much superior to the tube-drainage, temporary type of procedure. Its advantages are that it completely diverts the faecal contents, which gives the best possible relief of obstruction, it permits the cleansing by irrigation of the operative field in the distal colon so that something akin to an aseptic resection and anastomosis may be done—whether by open suture or by some special technique—it absolutely prevents any strain on the suture line by distention by gas and faecal matter, and any soiling from the same source. Its disadvantages may be alleged to be greater difficulty in execution, and the necessity of formal closure. As a matter of fact, it is no more difficult to make a permanent than a temporary type of colostomy, it occasions less wound infection, and as already pointed out its closure—for which no anaesthesia except local infiltration is necessary, is not difficult. There is no reason why in favorable cases the colon at the seat of the proposed resection may not be rendered practically aseptic. If the lesion has caused obstruction and much faecal material has accumulated proximal to it, but distal to the colostomy, difficulty may be experienced in clearing it out, but usually with the rest afforded by the colostomy and the consequent subsidence of oedema and inflammation the passage of the bowel contents, softened by appropriate means, can be secured, and in any event if it remains in the colon it will not threaten the anastomosis until healing is complete and the colostomy closed.

An attempt may be made to formulate a plan for the selection of the appropriate operation for carcinoma of the colon, on the basis of the experience above recounted, as follows: in a lesion of the right colon from the ileo-caecal valve to a point beyond the hepatic flexure, the entire right colon should be removed and a suture anastomosis made between the end of the ileum and the side of the colon, a provisional proximal jejunostomy may be made by the Witzel method, but is probably unnecessary. In carcinoma of the transverse colon, a caecostomy should be made, using a large-calibre rubber tube, followed after its function is well established, by resection of the lesion and end-to-end anastomosis by any recognized method of suture. Probably the cecostomy may be omitted with slight risk. In lesions of the

- <sup>10</sup> Richardson, E P Diagnosis and Principles of Treatment of Carcinoma of the Colon  
N E J Med, vol cciii, pp 455-458, 1930
- <sup>11</sup> Bolling, Richard W Carcinoma of Left Colon S Clin No Am, vol 18, pp 733-  
740, 1929
- <sup>12</sup> Lockhart-Mummery, P E Diseases of the Colon and Rectum and Their Surgical  
Treatment London, Bailliere, Tindall and Cox, 1923
- <sup>13</sup> deMartel, T Colectomy for Cancer Proc Roy Soc Med, vol 81, p 1807,  
1927-28
- <sup>14</sup> Grey-Turner G Cancer of the Colon Lancet, vol ccxvi, p 1017, 1929
- <sup>15</sup> Pfeiffer, T B, and Smyth, C M Carcinoma of the Colon S Clin No Am,  
vol 111, pp 869-876, 1928

The symptoms of carcinoma are notoriously inconspicuous. Prior to the onset of obstructive phenomena bearing on the diagnosis there are some points in the history that if present are significant. The most important is change of intestinal habit lasting from a week to a month. Among the others are abdominal distress, dyspepsia, occult blood, weakness and anæmia, urgency with futile attempts, palpable tumor in the right side, loss of weight and strength, constipation, blood and mucus. When low down in the rectosigmoid area, the partial obstruction may cause the classical compensatory diarrhoea. The duration of carcinomatous growth before recognizable in men is 7-8 months, in women 8-9 months. (Morrison)

When there is any type of intestinal dysfunction, such common and all-pervading symptoms as constipation and diarrhoea are probably dismissed with less careful inquiry and investigation than any other one presenting symptom.

Prior to obstruction, progressive constipation exists in from one-fourth to one-half of the patients in the presence of a low left-sided lesion.

The question may well be asked how long should constipation be treated symptomatically without an examination and without thought of its mechanical cause? Moynihan says "In left colonic growths, constipation is the rule, while in right colonic growths constipation is rare."

*Chronic intestinal obstruction* probably exists in a greater or less degree in 40 per cent of the cases, when seen by the surgeon. When not well marked, it can only be inferred by the intestinal distention with cramps and irregularity of bowel movement. Sometimes the patient has a definite sensation of stoppage of the faecal flow at a certain point which he will indicate. Moreover, the gurgling of gases through the stenosed area is audible and should be listened for.

Cases diagnosed rather cavalierly as "intestinal indigestion" on account of bloating and mild distress, often mean carcinoma. Chronic appendicitis, a diagnosis which always requires support and creates suspicion, may, in an elderly person, be a masquerade for carcinoma. Medical treatment is a positive disadvantage because restricted diet and mineral oil unfortunately obviate the pain that a generous diet and a lack of solubility of stools would produce, which would necessitate a more careful investigation. Partial obstruction associated with abdominal cramps and urgency of bowel movement, perhaps with diarrhoea, is sometimes associated with streaking of the stool with blood. This would be the colloid, adeno-carcinoma, with ulceration and resulting fixation and tumefaction. Partial obstruction over several days temporarily relieved by enemata, may recur after days or weeks and sometimes months of relative freedom, only to reappear with redoubled vigor or with complete obstruction.

Visible peristalsis is not as appreciable in the large intestine as it is in the small and can be, of course, seen more easily in thin subjects and when seen is of a sluggish undulation more prolonged. In the low, recurring type of partial obstruction, not due to annular constriction, the patient may bear



ously diagnosed or even examined by digital method. Failure to examine the rectum not only for suspicious symptoms but in a routine physical examination is one of the scandals of our diagnostic errors. Low-lying growths can be visualized by the sigmoidoscope and if possible a biopsy may be made to determine the grade of cancer and its bearing upon advice and prognosis. Surgeons may not need the admonition to use extreme gentleness. Gray Turner refers to five cases in his knowledge of perforation of the sigmoid by the sigmoidoscope, one in his own hands resulting fatally although immediate abdominal section and suture were carried out. In unlocalized obstruction the blind cæcostomy, under local anæsthesia without exploration, is the procedure of choice.

Obstruction occurs six times as often on the left half of the colon, in the experience of Burgess, as it does in the right half—87 per cent versus 13 per cent. A simple colostomy, however, is a serious undertaking as in the Brigham Hospital series the mortality was 39.1 per cent and Gray Turner's was 39 per cent. Resections in both of these clinics were about 19 per cent only. With preliminary colostomy it was  $9\frac{1}{2}$  per cent and without it was  $35\frac{1}{2}$  per cent.

The permeability of the diseased gut, with the trauma of the handling, invites an exudate of virulent microorganisms. This largely explains the higher death-rate of palliative colostomy. The amount of manipulation required to determine its obstructiveness and the future operability is ill-timed. It sets free the highly septic flora of the obstructed growth and sets up a degree of peritonitis that in aged, debilitated, dehydrated patients is so often fatal. It is the toxicity of the imprisoned secretions above the obstruction that gives the added danger to exploration. Thus in a small number of acute obstructions at the Mayo Clinic, the mortality for colostomy was 42.85 per cent, whereas palliative colostomy, on account of inoperability, gave a mortality of 7.67 per cent and colostomy in the group where further operation was considered advisable was only 2.7 per cent. Generally speaking the "blind cæcostomy" proposed by Stiles in the acutely ill and completely obstructed patient is wise and safer surgery. The Gibson type of cæcostomy with a three-quarter-inch tube is satisfactory.

With spinal analgesia and a moderate Trendelenburg position, in not too obese subjects, the parietal wall can often be elevated and mobilized sufficiently to visualize the lesion without the danger of unwarranted and dangerous exploration to determine the location.

If any exploration at all is done, the general abdominal examination, liver, *etc.*, should be alone carried out. In any event it should precede even the most superficial examination of the growth. Everyone can recall instances where only an exploration to determine the site and character of the lesion would have prevented disaster. Therefore spinal analgesia, and its amazing relaxation, allowing visualization, is a most helpful substitute for manipulation.

## SURGERY OF THE LARGE INTESTINE

By WILLIAM J MAYO, M D

OF ROCHESTER, MINNESOTA

I HAVE been asked by the officers of the American Surgical Association to present a paper on surgery of the large intestine, based on the records of the Mayo Clinic from the first radical operation, in 1890, to January 1 1931. In this period, 5,426 operations were performed on the cæcum and ascending colon, transverse colon, sigmoid, and rectosigmoid, and 3,312 on the rectum. In reviewing this mass of data representing forty-one years of a developing field of surgery, one finds much of interest but also much which would take up time unprofitably.

In an endeavor to deal with so large a mass of statistics of operations performed by several surgeons over a long period, it is difficult to do more than to state generalities, and these generalities should not be granted such weight as the number of cases reported might indicate, lest significance be attached to quantity rather than to quality. It should be remembered that reports of smaller groupings of statistics presented by surgeons who have worked up their cases in great detail from every standpoint might in many respects have greater significance than composite statistics such as I might present.

The statistics given in detail in the accompanying charts, for which I am indebted to Dr. Fred W. Rankin, are for the years 1929 and 1930. For the earlier years from 1890 to 1929, I shall content myself with brief historic comments on the growth of our knowledge in this field.

First I should like to direct attention to some of the physiologic and anatomic facts which have been developed in this period largely through clinical investigation and research. The significant fact to be deduced is the gradual change from surgery controlled by gross pathology to surgery based on physiology. It should be noted that the understanding of early processes which lead to the late manifestations of disease which controlled surgery in the past is helping us to a broader comprehension of disease in its earlier stages and consequently an increased percentage of cures. In this better knowledge the Roentgen-rays and various forms of endoscopic examination are playing a remarkable part.

*Physiologic and Anatomic Considerations*—In any consideration of an organ we always think of anatomy as fundamental, but in reality physiology is the architect which designs the anatomic structure.

Embryologically, the colon has its origin on the left side of the body, and the small intestine in six primary convolutions on the right side. At about the eleventh week the embryonic colon begins to move to the right, and continues to move until the head of the colon reaches its normal situation soon after birth. The right half of the colon originates with the small intestine

The autonomic nervous system is largely independent of the central nervous system. The autonomic fibres regulate the action of the gastro-intestinal tract, and the other viscera, the ductless glands, the blood-vessels, and all organs containing involuntary muscle.

The autonomic nervous system has for one of the most important tissues under its control the non-striated muscle, which was probably the oldest of all forms of control. Then came the internal secretions followed by the sympathetic nervous system, the internal secretions might be said picturesquely to play on the sympathetic nervous system to produce its results as hands and fingers play on the piano. This association with the non-striated muscle is well shown in the intramural plexuses of the gastro-intestinal tract, as described by Keith, and again by intestinal peristalsis, several contractions to the minute, and that vascular type of peristalsis which occurs eighteen to twenty times a minute and acts as the heart of the portal circulation to the liver.

Gaskell described the small, round, medullated nerves which connect the anterior horns of the spinal column with the great sympathetic nodes, all of which are direct connections, except those which pass to and through the suprarenal glands before reaching the ganglions, showing the close connection between the important internal secretion of the suprarenal glands and the sympathetic system. Langley described the parasympathetic nerves, the vagus and pelvic nerve.

We begin to see that certain obscure happenings in connection with the large intestine may be due to localized spasms of the smooth muscle layer of the blood-vessels. Again, now that we are getting new light on the sympathetic nervous system, which acts as a brake on intestinal peristalsis, we see a possible explanation of some phases of the development of diverticulosis. Learmonth and Markowitz have shown that after section of the inhibitory nerves to the colon of the dog, a barium meal may produce an appearance suggestive of early diverticulosis.

The work of Hunter and Royle has stimulated fresh surgical interest in the sympathetic nervous system. In this field Adson, Rowntree, and their associates have been able to relieve megacolon and similar disorders which resemble the dilated œsophagus in cardiospasm, by removal of the lumbar sympathetic ganglions and their communicating branches. The operation effects its purpose probably by leaving the sacral sympathetic outflow, which is motor to the distal part of the colon, in sole control of this part of the bowel. Such procedures have also brought about marvelous relief in Raynaud's disease, in disease of the blood-vessels of the extremities, in which one element is contraction, leading to gangrene, such as is seen in Buerger's disease, and in certain types of chronic arthritis, by removal of appropriate sympathetic ganglions and their communicating branches.

In 1909, I presented before this Association the results of some anatomic investigations which developed the fact that the external peritoneal attachments of the colon on the right side did not contain blood-vessels or other structures of importance and that these attachments to the lateral abdominal

These were the first instances recorded in which an actual demonstration of the pathologic change in diverticulitis was made during the life of a patient. I presented a paper on diverticulosis at the last meeting of the Association (1930), and I have nothing of importance to add to the subject.

*Malignant Disease*—C. H. Mayo taught us to wrap the colon with the omentum in cases in which the blood supply was seriously injured, and also to use the omentum to protect the anastomosis in resections as far as possible, sometimes drawing the colon through an artificial opening in the omentum and attaching it to the parietal peritoneum, so that if perforation occurred at the site of union, the peritoneal cavity would be protected.

In surgery of the sigmoid the anatomic relation of the ureters in the pelvis must be taken into consideration. On the left side, especially, the ureter may be and often is so closely attached to a growth in the lower part of the sigmoid that it cannot be separated without the possibility of leaving a portion of the growth with the adherent ureter. In my first case of this character, after a difficult operation, finding an otherwise normal ureter closely attached to the involved sigmoid in a removable malignant growth, I cut and tied it at the brim of the pelvis and removed the lower part of the ureter with the growth, intending to remove the kidney at the same time. The condition of the patient did not permit such a manoeuvre, but I expected to be compelled to remove it when the patient was sufficiently recovered. I found, to my surprise, that no ill effects followed. The patient lived more than eight years in good health, and died from another cause. Since that time, on similar occasions I have not hesitated to tie and cut a normal ureter, bringing about dysfunction and atrophy, and without harm. I have no doubt that accidental cutting of a ureter happens occasionally on one side in performing hysterectomy without any one's being the wiser.

In 1917, I first performed transperitoneal sigmoidotomy for removal of a bleeding papillomatous growth, and found it very easy of accomplishment. After incising the sigmoid, the growth, which was single, was brought out of the sigmoid and the cone of normal mucous membrane at the base was ligated and cut with the cautery. The sigmoid was closed and the wound was closed without drainage. We have had a number of cases of this general description without a death, and have found the procedure much safer in every way than resection. None of the patients has had further trouble.

It frequently happens that in the course of an exploration because of carcinoma, the finding of enlarged lymph-nodes has acted to interrupt a radical operation. Unless such a node is removed and shown to be carcinomatous, the conclusion that excision is useless is not always justified. In many instances we have operated on patients who have had such explorations and have found at later operation that the nodes were not carcinomatous, and radical operation was performed successfully.

There are some exceptions to the inadvisability of radical operation for incurable carcinoma, the chief of which is removal of an operable primary growth when secondary growths are present in certain situations—for instance, in the liver. The liver has the greatest power of regeneration of

tanned catgut One or two other rows of interrupted sutures of the same material are placed and the ends are left long These sutures are sometimes under tension, and under ordinary conditions would appear to be unsafe The peritoneal cavity is then opened and the adhesions to the affected loop are separated and the bowel is dropped into the peritoneal cavity The long ends of the suture are threaded in a needle and passed through the parietal peritoneum just above the wound The wound is then closed loosely in layers with catgut, drainage being placed down to the peritoneum Here sutures approximate the bowel snugly to the parietal peritoneum If there is fecal leakage it does not occur for at least several days, and in the meantime the general peritoneal cavity has been thoroughly protected by adhesion to the parietal peritoneum There is almost always some suppuration, but usually no fecal matter appears In ten days after the resection has been done the union at the site of resection has probably become firm

In one type of case, in which the patient is fat or the tumor is large or adherent, end-to-end or even lateral anastomosis is probably inadvisable Here the Mickulicz type of procedure is doubtless best The bowel is mobilized, the mesentery is severed and tied as though the resection were to be done immediately, and then the affected loop is brought onto the abdominal wound Two rows of sutures appose the portion of the bowel where the spur is to be, taking care to bring together the walls of the bowel which contain no large vessels Drainage of gauze and tubes is placed into the peritoneal cavity, reaching to the stump of the severed mesentery The loops in the bowel are doubly clamped and divided with the electric cautery The clamps on the stumps are left on for at least several days, the drainage is removed in two or three days The spur is opened by applying a soft-bladed clamp such as is used for occluding the bowel during intestinal anastomosis, clamping this gently, so that only the tips at first become engaged, and then after twenty-four hours the clamp can be more firmly applied and the bowel will not slip from its grasp

As illustrations of these two types of operations, Doctor Horsley reported these two cases

Mrs L H, aged seventy-three years, was quite fat and in rather poor physical condition The left half of the transverse colon had a large necrotic carcinomatous ulcer with some adhesions and a few large lymph-nodes The type of Mickulicz operation that has been mentioned was done, and the patient made a satisfactory recovery

A patient representing the type of end-to-end suture that has been described was Mrs A M B, aged eighty-four years There was an annular carcinoma of the sigmoid A complete enterostomy with a glass tube was done on the right side, and ten days later a resection was done with end-to-end union as described There were a few involved lymph-nodes in the mesentery attached to the resected portion of the bowel Ten days after the resection, the enterostomy was closed After closing the enterostomy there was rather marked bronchitis, which, for a while, seemed ominous, but she recovered from this in a few days and made a satisfactory convalescence There was never any trouble about the abdominal healing

Doctor Horsley felt that in every case, whatever the technic of resection is, whether there is an obstruction or not, it is important to do an enterostomy at least ten days before and to do it in such a manner that one can tie it off, and, at the same time, so that it can be easily closed later on

DR LEONARD FREEMAN (Denver, Colo) said the old controversy that has gone on for so many years as to which is the better method of uniting the large bowel after a resection, as to whether it should be done end-to-end, or side-to-side, has been decided, in this country at least, pretty well in favor of the end-to-end anastomosis, in spite of the fact that the side-to-side anastomosis offers a much better field for work in the peritoneum and the blood supply is better

He did not believe this to be properly decided Quite recently Finnstere, in Vienna, has suggested a method by which the side-to-side anastomosis can be done with a great deal of safety He has used a method for a number of years, and has had opportunity

in dragging it far enough out of the incision, one is very likely to have either sloughing of bowel from tension or to have metastasis occur in the abdominal wall

On the other hand, if one finds growths which are attached laterally much inflamed, as one frequently sees these growths, and if one goes and breaks up the adhesions and tries dragging them out, and there has been a great amount of contraction from the inflammation surrounding the growth, in that type of case one will stand a large chance of having metastasis occur in the abdominal wall

The Mikulicz operation, in the properly suited cases, is a very safe-and-sound operation, but it is often misused, and many of the bad results which one sees from it, and many of the metastases in the abdominal wall, come from efforts to use it in cases in which it is unsuited

DR REA SMITH (Los Angeles, California) remarked that he never felt safe with any suture line on the left side of the colon. He always felt safer when it was on the right. The reason a tube is not used as often as it should be is because it is so hard to have a nurse pass it during the operation. A great deal of trauma results and the operation is lengthened by the passing of a sigmoidoscope before the anæsthetic. But placing a tube up in the sigmoid and leaving it there he finds of great value because after the suture line it can be slipped through without any trouble.

DR DAVID CHEEVER said that for Doctor Haggard's blind cæcostomy he would substitute a high right transverse colostomy, for the reason that if the obstruction is in the colon 9 chances to 1 it is carcinoma, and if it is carcinoma 65 chances to 1 it is distal to that point. So if one makes a colostomy there one is going to relieve all the obstruction, completely divert the current, and give the best chance for a more radical operation at a later date. Whereas, if the lesion is carcinoma, and in the proximal colon, the cæcostomy does no good.

In regard to the Mikulicz operation, Doctor Cheever was surprised that his feeble attack on it did not bring out more objections because it seems to be so widely accepted throughout literature as, on the whole, the best procedure. The actual facts from the records of the Brigham Hospital which he quoted seem to justify him in taking the position which he did. They show, in brief, that the radical operations on the distal colon by the Mikulicz method carry a considerably higher mortality than those made by the open suture method, that the period of hospitalization is considerably longer, and that a much larger percentage were still incompletely healed when the patients were discharged from the hospital. The evidence as far as his small experience goes is very strongly in favor of the open suture resection after a preliminary colostomy, as against the Mikulicz.

Another thing, in perusing the house officers' memoranda of the subsequent cases in the hospital after the operation with the Mikulicz procedure, one constantly runs across such statements as "Application of clamp not satisfactory", "Clamp had to be re-applied", "Application of clamp quite painful", giving a distinct impression that the comfort of the patient after the Mikulicz resection is less than the comfort after the open suture resection.

To quote two authorities showing the wide divergence of opinion about the Mikulicz procedure. Coffey says, in a recent article, "Probably no more important principle has been introduced into intestinal surgery than the Mikulicz principle." And Bell, an English writer, says, "The Mikulicz procedure is grossly overvalued and should be abandoned except in certain instances."

Doctor Sistrunk, in an article on the Mikulicz method, lays down four conditions in which it is not suitable: (1) Growths with infection of the walls of the intestines (2) Large growths which are adherent (3) Obstructing growths (4) Patients with short mesenteries, and whose lesion is in the sigmoid.

That is a pretty large category which he lays down, and which he says himself are not the best type of case on which to employ the Mikulicz.

He certainly doesn't want to deny that the Mikulicz operation is a very possible and often a very good way of making an anastomosis in these cases, but the number

# THE ACTION OF SODIUM CHLORIDE UPON THE SMALL INTESTINE

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IN THE investigation of the rôle played by sodium chloride in the body, the work of Hughson and Scarff<sup>1</sup> will always stand out as an initial stimulus for such experimentation. In 1924 these authors noted that the intravenous injection of hypertonic sodium-chloride solution would cause active peristalsis and suggested that post-operative distention, a mild form of ileus, might very well be avoided by the use of sodium-chloride solution. They report two cases of adynamic ileus successfully treated with salt after the failure of pituitrin, stupes and oral and rectal medication. Dreyer and Tsung<sup>2</sup> have also noted in experimental animals that hypertonic solutions of sodium chloride cause an increase in intestinal movements. No effect was noted by these observers when an isotonic solution was used. A number of French authors (<sup>3</sup> to <sup>12</sup>) have used hypertonic salt solution as a therapeutic agent in the various types of ileus. Their published reports are all favorable. Patry,<sup>13</sup> Battista,<sup>14</sup> Ross,<sup>15</sup> and Coleman<sup>16</sup> also record good results in clinical cases. The solution has been used in all cases to stimulate peristalsis.

In recent years the importance of sodium chloride in the treatment of intestinal obstruction and peritonitis has been frequently emphasized. One of the most interesting observations has been the relationship of salt to the chemical changes occurring in the blood, incident to obstruction of the small bowel. The rise in non-protein nitrogen and carbon dioxide combining power, and the fall of the chlorides as a result of high intestinal obstruction can be experimentally prevented and controlled by the administration

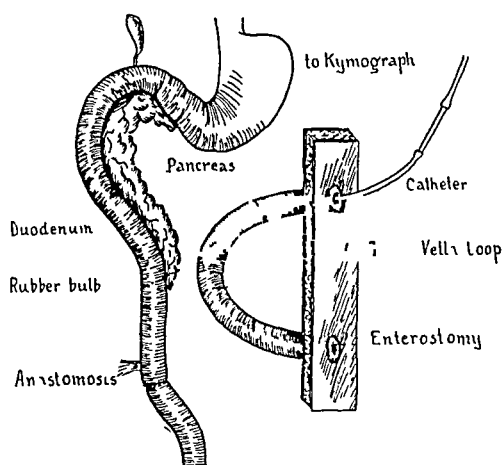


FIG 1—Thiry Vella loop of upper jejunum

of sodium-chloride solution. Since distilled water, glucose solutions, sodium bicarbonate and other salts have no such action, it is concluded that sodium chloride plays a specific rôle in maintaining the water distribution and balance in the body as well as being an important factor in stabilizing the chemical balance. Hughson and Scarff have made the interesting observation that an intravenous injection of hypertonic salt solution decreases the ab-

sorption rate of water from an isolated loop of intestine. Experimental evidence presented by Carlson and Wangenstein,<sup>17</sup> Ochsner, Gage and Cutting<sup>18</sup> and others conclusively prove that the administration of hypertonic sodium-chloride solution stimulates both the intestinal tone and peristalsis. Lehman and Gibson<sup>19</sup> have noted that a 2 per cent solution of sodium chloride introduced into the stomach will stimulate forward peristalsis and relieve nausea and vomiting. It is probable that the sodium chloride acts directly upon the muscle of the bowel.

In a series of experiments on dogs we have tested the action of sodium chloride both before and after obstruction of the small bowel. In the first series a Thiry-Vella loop (Fig 1) was made and tracings of the normal intestine taken on kymograph records after administering intravenously salt and glucose solutions of varying concentration.<sup>20</sup> In the second series, a preliminary jejunostomy was done by two different methods. The first method used was a simple section of the jejunum about 12 to 18 inches below

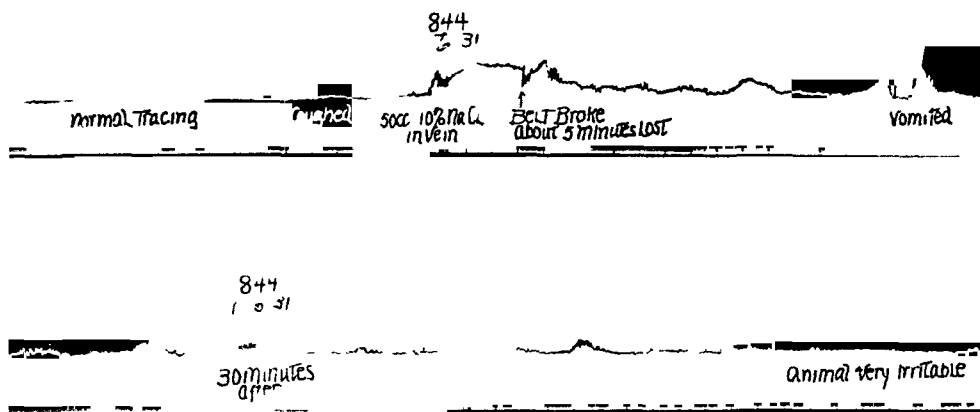


FIG 5—Kymographic tracing of upper jejunum forty eight hours after obstruction

the ligament of Treitz with an end-to-side anastomosis between the proximal segment and the jejunum below the site of section and a fixation of the cut end of the distal segment beneath the skin. After the wound was soundly healed the abdomen was reopened, the bowel obstructed about 12 to 18 inches below the anastomosis and the end beneath the skin opened, producing a jejunal fistula (Fig 2). The second method was that suggested by Mann and Bollman<sup>21</sup> and Scott and Ivy<sup>22</sup> in which a segment of the lower ileum was transplanted between the upper jejunum and the skin of the upper abdominal wall to produce a jejunal fistula (Fig 3). We prefer the latter method since there is less leakage of upper intestinal juices which endangers the life of the animal.<sup>23</sup> At the operation for obstruction of the jejunum, a rubber bulb with catheter attached was placed in the obstructed portion of the gut while the abdomen was opened. In some cases a slight constriction of the bowel was made with a ligature proximal to the bulb to prevent its regurgitation. In almost every experiment a hypertonic



quite striking<sup>24</sup> A high percentage of patients having abdominal pain associated with moderate distention respond to the intravenous injection of 20 cubic centimetres of a 10 per cent sodium-chloride solution with the passage of flatus and relief from pain It is frequently necessary to repeat this dose from one to three times In the more seriously ill patients with impending paralytic ileus or intestinal obstruction, 500 cubic centimetres of a 5 per cent solution is usually used as an initial dose if the blood chlorides are much below normal The importance of giving hypertonic solutions very slowly must be realized In the Kansas University Hospital we have adopted the rule that 20 cubic centimetres of a 10 per cent solution must be given over a period of five minutes and 500 cubic centimetres of a 5 per cent solution must consume at least one hour Given at these rates we have not had any bad results A local thrombus will at times form in a vein, rendering it unfit for immediate future use

In the treatment of patients having dehydration and hypochloræmia, it is essential to know that glucose is not a substitute for sodium chloride Gamble and Ross<sup>25</sup> emphasize this point when they state that sodium chloride is the only one of a long list of salts containing both of the ions specifically required for plasma repair It is, therefore, important to recognize the fact that a solution of sodium chloride acts as a specific in those patients having marked fluid and chloride loss

#### CONCLUSIONS

(1) Experimental studies and clinical observations indicate that sodium chloride in hypertonic solutions increases the tone of the small intestine and stimulates peristalsis

(2) The intravenous administration of hypertonic sodium-chloride solution as a peristaltic stimulant is indicated in post-operative distention with "gas pains," paralytic ileus, and as an adjunct to the treatment of intestinal obstruction after the obstruction has been relieved either by direct attack or by enterostomy

(3) The administration of sodium-chloride solution in proper concentration is considered a specific treatment for the dehydration and hypochloræmia incident to the various types of ileus

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## SPINAL ANÆSTHESIA

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THIS paper is concerned with a clinical analysis of spinal anæsthesia and with the status of our present attitude toward its usefulness. Countless articles on the subject indicate the general acceptance of this form of anæsthesia. Emphasis has been placed upon the desirable features and upon the technic of administration under such titles as "Controllable Spinal anæsthesia" and "The Safe Spinal Anæsthetic." A smoother convalescence and an absence of pulmonary complications were promised. We have been urged to use spinal anæsthesia in preference to a general anæsthesia in the poor risk case. Some advocate the adoption of this form of anæsthesia for every major procedure, irrespective of age, location of the operative area, or general status of the patient. There is a paucity, however, of clinical reports which include failures, fatalities and immediate or remote untoward effects. There has been a reversal in our opinion about certain features of spinal anæsthesia. Because of the well-recognized advantages from the standpoint of the surgeon, spinal anæsthesia will continue to be the anæsthesia of choice in a large proportion of cases. We are coming, however, to regard it as an anæsthetic of less potential safety and therefore not as applicable to the poor risk case as was first thought.

When the use of spinal anæsthesia was first revived three years ago on the Surgical Division B of the Hospital of the University of Pennsylvania, special charts for detailed notations about these cases were provided. Up to the present time 533 cases have been given a spinal anæsthetic and 78 per cent of these have been seen in the follow-up clinic or communicated with by letter.

The proprietary preparation known as "Spinocaine"<sup>1</sup> a novocaine, alcohol, starch solution, was used in the first 114 cases. Among this series there were nine failures of the drug to produce anæsthesia. We were very much concerned about the lives of two patients because of the development of a sterile meningitis. One patient lost control of the urinary bladder for three months. In this group of 114 cases there was one table death. The follow-up reports show, that in this early series only one had any untoward symptom later which might be attributable to the anæsthetic. After twenty-two months this patient still complained of paresthesias in the lower extremities. Neurologic examination was not significant.

We next changed to the use of Neocaine, a French preparation similar in formula and toxicity to Novocaine. The crystals readily dissolve in the spinal fluid. In this way fresh solutions are certain and no foreign material

the operation was to be in the upper abdomen although on three occasions the operative site was the inguinal region (See Table I)

TABLE I  
*The Success of Spinal Anæsthesia*

	Cases	Per cent
Total Number of Cases	533	
Entirely Satisfactory	453	85
Partially Satisfactory		
General Anæsthesia to finish	41	7.7
General Anæsthesia supplemented	20	3.7
Complete Failures	19	3.6
Spinocaine	9	7.9
Neocaine	10	2.4

The most disturbing and serious factor associated with spinal anæsthesia is the possibility of a marked fall in blood-pressure. A primary, then a secondary decrease in the blood-pressure may occur. The first or early blood-

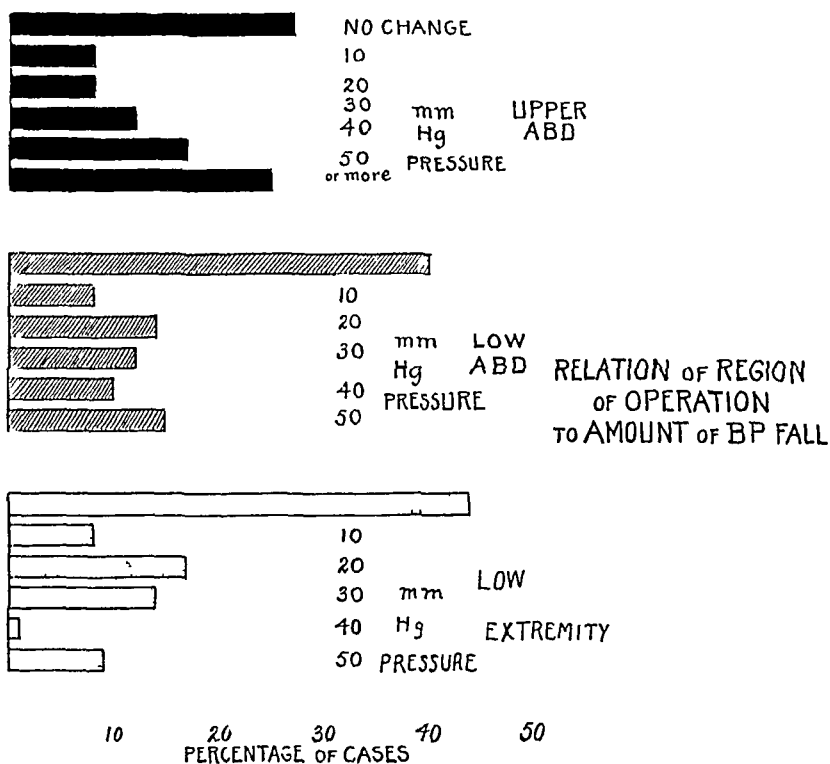


FIG. 1.—Graph showing the relation between the region of the operation and amount of the blood pressure fall. The length of the columns indicates the percentage of cases in each group. The first column in each group represents the percentage of cases in which no change in the blood pressure occurred during the period of anæsthesia. Between 30 and 40 per cent showed no change in matter where the operation was performed. It is interesting to note that 9 per cent of the patients who had an operation on a lower extremity were subjected to a blood pressure fall of 50 millimetres of mercury or more.

pressure change comes in the first twenty minutes and is dependent upon the action of the drug itself. The delayed or secondary fall is the resultant

the operation may leave the blood-pressure at an unrecoverable level. In eight cases, which died of shock a few hours after operation, the blood-pressure never was brought back from the low level induced by spinal anaesthesia. It is probable that the temporary spinal paralysis was a contributing factor in the initiation of the state of shock. Other conditions were present in all cases and the evaluation of the relative importance of the various contributing factors in each particular case is difficult. A brief resume of three such cases follow.

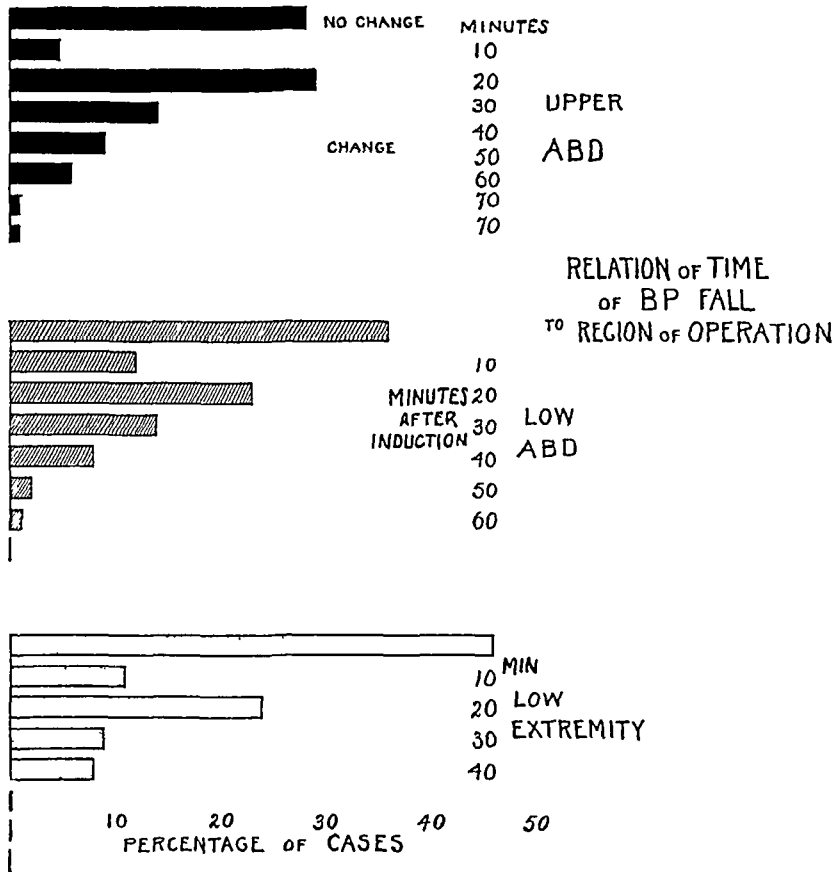


FIG 2—Graph showing the relation between the region of the operation and the time that the maximum decline in blood pressure took place. Note that in all of the groups the maximum fall in most patients, if one occurred was twenty minutes after the induction of the anaesthesia. In the upper abdominal group a small per cent of the patients experienced the greatest fall in the blood pressure as late as fifty or sixty minutes after induction. These late falls in blood pressure represent the influence of associated factors incident to the operation or to the patient's disease.

**CASE I**—Mrs R M, aged fifty-eight. Gall-bladder disease, jaundiced four weeks. In hospital eight days for observation and pre-operative preparation. Blood-pressure 160/75, temperature, pulse, respiration normal. Ephedrine 100 milligrams given intramuscularly followed by spinocaine 3.5 cubic centimetres intraspinally. Cholecystectomy and choledochotomy done. Liver showed a moderate cirrhosis. Duration of operation sixty minutes. Steady decline in blood-pressure to 110/70 during first thirty minutes. Blood-pressure on return to ward 100/60. Patient died thirteen hours after operation after being in extreme shock for one hour. Autopsy failed to explain cause of death. A small amount of blood was found in the right sub-diaphragmatic space.

tion There was evidence of renal damage Blood-pressure 180/110 Was given ephedrine, 50 milligrams and neocaine, 200 milligrams Exploratory laparotomy for intestinal obstruction, subacute, and excision of metastatic lesion and lateral ileoileal anastomosis Operating time, seventy minutes Blood-pressure fell 70/40 during most of the operation and toward the end was brought up to 110/80 following intravenous 5 per cent glucose After return to room, blood-pressure never exceeded 130 systolic Death in thirty-one hours Uræmia acidosis or hæmorrhage was not in evidence At autopsy a left hydronephrosis and an early simple nephrosis on the right was found

Rapoport,<sup>4</sup> Arnheim and Mage,<sup>5</sup> McKittrick, McClure and Sweet<sup>6</sup> and Falk<sup>7</sup> have reported early post-operative deaths in which the spinal anæsthetic was held partly responsible It is our practice now not to give a spinal anæsthetic to any patient who before operation or who may during or after the operation, possess other conditions which tend to produce a low blood-pressure Burch, Harrison and Blalock,<sup>8</sup> have shown that animals under spinal anæsthesia do not stand hæmorrhage as well as those under general anæsthesia Our clinical experience supports their observation and further shows that other shock-producing agencies are not well tolerated The preliminary rise in blood-pressure that follows the use of ephedrine given thirty minutes prior to the spinal anæsthetic has served as a good index of the flexibility or reserve of the vasomotor mechanism Those cases which failed to show a rise with ephedrine were more likely to be depressed by the spinal anæsthetic

In this series there were two spinal anæsthetic deaths, a mortality of 0.37 per cent

CASE I—Mr J S, aged sixty-nine Symptoms and signs of intestinal obstruction of five days' duration Critically ill, flushed, distended and tense abdomen Had hemiplegia for four years Blood-pressure 124/90, temperature, pulse, respiration 100°-98-24 Intravenous saline, 1,000 cubic centimetres was given immediately and operation prepared Spinal tap dry Three cubic centimetres spinocaine was injected into what was thought to be the spinal canal Anæsthesia was secured to the level of the fifth thoracic segment The blood-pressure immediately fell to 65/0 Upon exploration of the abdomen a general peritonitis was found There was a volvulus involving the terminal ileum and a second point of obstruction in the small bowel produced by adhesions to the hepatic flexure At the conclusion of the operation there was a sudden cessation of respiration and of cardiac action simultaneously forty minutes after the anæsthetic was given Artificial respiration, stimulants and an intravenous infusion were administered The time of death, after forty minutes, would indicate that it was not primarily due to respiratory paralysis The prolonged hypotension, the result of a combination of factors, with the associated oxygen lack in all the tissues, including the medulla and heart is the most probable explanation for the death in this case Although this form of anæsthesia provided the most satisfactory relaxation for exploration of the abdomen, it was a mistake to administer it in the presence of other shock-producing factors

The second spinal death occurred late in our series when errors in technic or management were less likely and in a patient whose general condition was considered good

CASE II—Mrs A H, aged fifty-six This patient had had symptoms for one year, principally pain in the left lower quadrant of the abdomen Bed-ridden for four weeks Ascites and a mass in the lower abdomen were found General condition good

present in 31 per cent of the cases and vomiting in 14 per cent. The frequency was greater if the operation was carried out in the upper abdomen. The anaesthetists were concerned about the respiratory activity or the patients complained of difficulty in breathing in 6 per cent of the cases. In two cases in which spinal anaesthesia was given for short lower abdominal operations, the patients went into a latent or secondary shock two and one-half and five hours after operation. There was a sudden fall in blood-pressure, difficulty in breathing, rigid abdomen and a disorganized type of upper costal activity without any evidence of diaphragmatic movement. It was thought that much of the peculiar course of events in these cases was due to the sudden appearance of pain.

TABLE III  
*Immediate Untoward Effects*  
(Percentages)

	Region of Operation		
	Upper Abdomen	Lower Abdomen	Perineal or Lower Exterior
Nausea	41	31	6
Vomiting	25	9	5
Respiratory Difficulties	8	6.5	1.6
Extreme Pallor	7	7.6	0
Cyanosis	2.2	0	1.6
Sweating	0.5	2.4	0
Shoulder Pain	4	2	0
Generalized Pruritus	0	1.3	0
Death During Anaesthesia (Two Cases)	0	0.7	0
Death During Anaesthesia, percentage of all cases			0.38

Untoward effects of spinal anaesthesia as encountered in the convalescent patient are relatively unimportant. (See Table IV.) Only 4 per cent complained of a transient headache and an equal small number had temporary urinary retention. Almost all of the patients who had difficulty in voiding had had inguinal or perineal operations. The incidence of such difficulties is as high with general anaesthesia. Two patients who developed signs and symptoms of meningitis, proved to have cloudy but sterile spinal fluid and both recovered. There were no residual effects in either case.

TABLE IV  
*Remote Untoward Effects of Spinal Anaesthesia*  
533 Cases                      78 per cent follow-up

	Cases	Per Cent
Headache	21	4
Voiding difficulties (Upper abdomen, 2, Lower abdomen, 17)	20	3.7
Persisting hypotension	8	1.5
Latent shock with return of sensation	2	0.4
Meningismus	2	0.4
Paresthesias lower extremity for two years	1	0.2
Tinnitus	1	0.2
Paralysis, any muscle group	0	0

(4) Sudden deaths after operation should be charged up partially against spinal anæsthesia when the hypotension induced by this form of anæsthesia persists

(5) The site of the operation or the dose of the drug has a surprisingly small influence upon the degree of the fall in blood-pressure or in the time at which the maximum fall takes place

(6) The incidence of pulmonary complications is not reduced by spinal anæsthesia

DISCUSSION—DR ALEXANDER PRIMROSE (Toronto, Canada) said, in connection with spinal anæsthesia, from the standpoint of the general surgeon, he was not prepared to discuss the details of the technic of spinal anæsthesia, or the value of the different forms of technic, but he did know that in abdominal operations it makes the work of the surgeon infinitely easier. He would like to put it this way. If there are harmful results from spinal anæsthesia, if certain results are attributed to spinal anæsthesia—he was inclined to believe that one minimizes the amount of trauma to the viscera under spinal anæsthesia and he believed that one can lower the mortality very much by handling the viscera delicately and gently—spinal anæsthesia prompts the surgeon to handle the viscera with the minimum amount of trauma.

As to the danger of the use of spinal anæsthesia in surgery above the diaphragm he recalled that one of his colleagues in Toronto, Doctor Shenstone's work has, at the present time, to his record eleven cases of lobectomy in which he has removed one lobe of the lung, and in some cases one lobe and part of another lobe. In these eleven cases he has had two deaths. The last six cases have been done under spinal anæsthesia. He is firmly convinced that the conditions under spinal anæsthesia are most favorable to a successful result in these cases.

DR HAROLD L FOSS (Danville, Pennsylvania) said that in a paper on the question of anæsthetics presented in Philadelphia a few weeks ago by a distinguished member of this Association, a man for whom we all have the highest regard, spinal anæsthesia is summarily discarded as are nearly all means of producing anæsthesia other than ethylene or ether or infiltration. This paper was not discussed. It will be read by thousands of physicians and surgeons in the country and its conclusions will be accepted by many, but he thought it should not go unchallenged.

He was greatly interested in determining if he were correct in his conclusions that spinal was proving, in his hands, a satisfactory and, what is even more important, a safe anæsthetic. In going over the records he discovered that his mortality, in general abdominal surgery, had dropped materially since he began, in certain cases, to use spinal anæsthesia in place of ether, a decrease that could be directly attributed to the change in anæsthetics. It was not only apparent in the general list but proved so in operations for specific conditions. In reviewing his first 200 consecutive cases of acute appendicitis performed under spinal and comparing them with the 200 preceding these and operated on under ether. Over 70 per cent of these patients had peritonitis when they reached him and the operations were all performed by him, in the same hospital, with the same personnel, and the same pre-operative and post-operative care, everything being equal except in the first 200 cases ether was used, in the following 200, spinal. There was an immediate reduction in mortality from 7.4 per cent to 4.2 per cent.

He then investigated his cases of acute perforating duodenal ulcer, his cases of acute intestinal obstruction and those of biliary tract disease. In all there was a definite, and he felt, significant decrease in mortality following his adoption of spinal in place of ether as an anæsthetic. Staff members are thoroughly convinced from the analysis of these results that the change in anæsthetics has, undoubtedly, brought about a definite reduction in mortality.

ward anesthetized for an hour when he could do the appendectomy practically always in twelve to twenty minutes. So we use local anæsthesia and just enough gas to keep them quiet.

There were times when he did use a spinal. For perforated ulcers it is perfect. One gets rid of the rigidity, which is never touched by a general anæsthetic, and enables one to do better work.

Doctor Scrimger spoke of the head down position. If one uses the neocaine solution it has a tendency to run down. Since they changed to neocaine he finds it necessary to keep them flatter. And here also, is where one is in between two difficult positions. If the patient has a tendency for the neocaine to work itself upward in spite of the flat position, in spite of a small dose, as it does in some patients, if one puts them in that head down position very often it drives the anæsthesia to a still higher point. So he tries to hold off just a little bit until the glucose solution gets started which tends to bring them up. Then, after twenty minutes' time or thereabouts, if necessary, if the hypotension is still prolonged, he holds them in a head down position.

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preferred, the ether seemingly counteracts the depressing effect of chloroform. There have been no complications from the chloroform. No supplementary anæsthesia is required unless the patient is actively restless.

*Technic*—On the evening preceding the operation the patient is given a light supper of tea and toast, nothing is allowed by mouth after midnight. No laxatives are given at any time, the cleansing of the bowel being accomplished by tap-water enemata. The administration should take place in a quiet and darkened room. At 5 A.M. on the morning of the operation the tap-water enemata are repeated. One and a half hours before the operation a chloretone suppository of 10 to 15 grains is given to be followed in fifteen minutes by a hypodermic of morphine sulphate grain  $\frac{1}{6}$  to  $\frac{1}{4}$ . Fifteen minutes later, with the patient in the left Sims' position, the following mixture is instilled into the rectum: ether ( $\frac{3}{4}$  V), olive oil ( $\frac{3}{4}$  IISS), paraldehyde ( $\frac{3}{4}$  ). It is essential that this be thoroughly mixed and given very slowly, at least ten to fifteen minutes being taken. A few patients suffer cramp-like pains in the abdomen and if their cooperation cannot be obtained they will expel the mixture. At the end of an hour in which there has been absolute quiet the patient is taken to the operating room. Immediately on return to the ward a colonic irrigation of tap water is given, followed by a retention enema of 6 ounces of hot coffee. Throughout the entire preparation and operation the patient should be closely supervised to prevent the danger of the tongue falling back in the throat.

The character of the anæsthesia obtained. The patient is analgized and carried on the threshold of surgical anæsthesia. Reliance being placed on the marked analgesia properties of colonic ether. Analgesia with consciousness is present in the majority of cases. Colonic anæsthesia produces relatively more analgesia than anæsthesia and often in late stages of an operation the patient is apparently completely conscious, yet the amnesic properties are such that the patient will not remember anything that took place in the operating room. Ether oil is always safe as a light narcosis and the eye lids and other reflexes are active, the patient relaxed and analgized. The ideal colonic anæsthesia yields a quiet and peaceful respiration in which the swallowing and respiratory reflexes are retained. Some of the most difficult and time-consuming operations about the head and neck can be successfully carried out as there is no venous congestion and no excessive production of saliva and mucus. The patient can be readily aroused by talking sharply to him.

*Contraindications*—It cannot be used with advantage in cases requiring complete muscular relaxation. As the reflexes are not abolished in the throat it is not a good anæsthesia for the ordinary tonsillectomy. It is contraindicated in diseases of the gastro-intestinal tract and rectum.

The post-operative recovery is smooth and takes place with fewer complications than in the inhalation method. There is little post-operative nausea and vomiting, fewer cardiac and pulmonary accidents. This was the deciding factor in changing from the inhalation method to the colonic and has

hours, 17·2 per cent lasted four hours, 10·1 per cent lasted five hours, 2·4 per cent lasted six hours, 0·7 per cent lasted seven hours, 62 per cent lasted eight hours. During the corresponding period, 1,532 inhalation anaesthetics were administered. The demonstrated increased safety and the diminished complication rate of colonic ether as compared to that of inhalation anaesthesia led to the abandonment of the inhalation method in all head and neck cases.

**The disadvantages of colonic anaesthesia.** It is not a universal anaesthetic, it does not give complete muscular relaxation, it is a complicated and time-consuming method which requires the cooperation of the patient for its administration and a competent person to watch the patient before and after the operation to prevent the swallowing of the tongue. The patient, unless under constant supervision, should never be allowed to lie flat on the back. It should not be used in emergency operations as time is required for the proper preparation of the rectum.

**The advantages are.** It is safe, it is controllable, as the ether can be washed out at any time. The prolonged analgesic properties of colonic ether (it may last from six to eight hours) make it possible to carry out extended operative procedures. Psychic trauma is absent, amnesia marked and the stage of excitement eliminated. The actual cautery can be used in the mouth and throat. It is useful in short-necked, obese individuals in other types of operation.

**Summary**—The following conclusion is based on the 2,150 cases of colonic ether anaesthesia with an anaesthetic mortality of five cases (0·24 per cent). Colonic ether anaesthesia is the safest and best for all patients with cancer of the head, neck, *etc.*, whose lesions require a general anaesthetic for their proper removal.

**Comment**—In order to shorten the preparatory period of anaesthesia we have been employing a mixture of avertin and oil ether. We are not yet ready to pass judgment on this procedure as we still consider it in the experimental stage.

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It seems timely, therefore, to make a critical analysis of the results of splenectomy in the more common diseases, concerning which sufficient data are available to warrant drawing conclusions. For this purpose, a study was made of the records of all cases of splenic anæmia (including Banti's disease), hæmolytic jaundice, and purpura hæmorrhagica, in which splenectomy was performed at The Mayo Clinic between December 31, 1908, and January 1, 1931. The series comprised 326 cases in which splenectomy was performed, in 167 of which the reason for operation was splenic anæmia, in 118, hæmolytic jaundice, and in forty-one, purpura hæmorrhagica. The clinical diagnosis was made in each instance by Giffin and his associates.

Since this paper is restricted to presentation of the results of operation in these diseases, consideration of the physiology and pathologic changes relative to the spleen, the pathogenesis of the diseases, the details of operative technic, and the general indications for splenectomy in other disorders have been omitted. However, for purposes of clarity, the prominent clinical and hæmatologic features on which a diagnosis was based, are summarized briefly. Many of the data used in this study have been published in papers by W. J. Mayo, and by Giffin.

*Splenic anæmia*—Osler defined splenic anæmia as "Intoxication of unknown nature, characterized by great chronicity, primary progressive enlargement of the spleen which cannot be correlated with any known cause, anæmia of secondary type, with leucopenia, a marked tendency to hæmorrhage, particularly from the stomach (œsophagus), and in many cases a terminal state with cirrhosis of the liver and jaundice." It is the late stage of anæmia, that is, the stage in which there is secondary involvement of the liver, as manifested by evidences of portal obstruction and hepatic insufficiency, that today is commonly designated as Banti's disease. Strangely enough, in the presence of an enlarged spleen and associated anæmia, the diagnosis of this syndrome rests on the absence of any known etiology, and it is little wonder that many observers question whether splenic anæmia should be considered as a clinical entity, for if the cause of the splenomegaly is identified, the diagnosis of splenic anæmia is forthwith excluded.

The course of the disease in cases in which operation has not been done is progressive, without any tendency toward abatement or spontaneous recovery, and the patient ultimately succumbs, usually within a few years, as a result of recurrent excessive hæmorrhages or hepatic insufficiency. The first manifestation of this syndrome is often discovered by the patient, or in a routine examination, as enlargement of the spleen, and in some instances the organ attains considerable dimensions without other recognizable evidence of the disease. Commonly, however, there are alterations in the blood when the patient presents himself for examination. These consist of secondary anæmia of varying degrees, and extreme poikilocytosis, leucopenia with lymphocytosis is not uncommonly present, but the leucocytes may be normal in number or even slightly increased.

One or more episodes of copious hæmorrhage from the gastro-intestinal

mortality of those aged less than forty years was only half that of patients aged more than forty years, about 53 per cent of patients aged less than forty years are still living, whereas only 40 per cent of those who are older are alive.

Owing to the difficulty of accurately estimating the functional efficiency of the liver, it is not possible to determine with exactness the influence which secondary hepatic injury has had on the operative results. Except in the more advanced cases, in which evidences of cirrhosis and portal obstruction are obvious, it is not always possible from clinical data to judge accurately the degree of hepatic injury. Likewise, in some cases in which gross changes characteristic of advanced cirrhosis are lacking, the surgeon is often unable, from observation of the size, color, and consistence of the organ, to estimate

Table 1  
Splenectomy for splenic anemia

Age by decades	Cases	Hospital mortality	Subsequent deaths	Living	Well	Fair	Poor	Not traced
0 - 9	11		5	5	4	1		1
10 - 19	19	2	7	10	8	2		
20 - 29	42	2	15	24	21	2	1	1
30 - 39	40	4	16	20	13	4	3	
40 - 49	30	3	14	12	10	1	1	1
50 - 59	20	4	8	8	7		1	
60 - 69	5	1	3	1		1		
Total	167	16	68	80	63	11	6	3

the degree of injury. In livers adjudged on gross examination to be only slightly enlarged or congested, microscopic examination of specimens removed for diagnostic purposes has demonstrated repeatedly the presence of marked hepatitis or degeneration of the parenchyma. Accordingly, in the appraisal of hepatic injury the surgeon is more likely to underestimate than to overestimate the seriousness of the condition, and unless biopsy is obtained, this potential error should be taken into consideration in the evaluation of the influence of hepatic disease on operative result. Pre-operative estimations of hepatic function, based on retention of bromsulphthalein, have been carried out in only thirty-two cases of splenic anæmia. It may be significant that the patient in this small series who died, belonged to a group of fifteen whose hepatic functional activity was believed to be impaired. As these tests have been employed only in recent years, sufficient time has not elapsed to permit a determination of their value in prognosis with regard to later results.

removal of the spleen in this disease greatly lightens the load which has been thrown on the liver by reducing, by at least 20 per cent the volume of blood entering the portal circulation, by removing possible toxic substances originating in the spleen, and by producing adhesions for the establishment of collateral circulation

In spite of the most gratifying benefit derived from the operation, even in many of the advanced cases, as evidenced by the improvement of the blood and of general health, and by prolongation of life, the recurrence of gastro-intestinal hæmorrhages in a large group of these cases presents a discouraging problem. In approximately 50 per cent of the ninety-eight cases in which there was gastro-intestinal hæmorrhage before operation, there has been one hæmorrhage or more subsequent to splenectomy. Since the hæmorrhage commonly results from rupture of greatly dilated varices situated beneath the mucous membrane of the lower end of the œsophagus, it has been suggested that this complication might possibly be minimized by tying the coronary vein, with the view of reducing the enormous turgescence by breaking communication with the portal circulation. In the hope of promoting additional collateral circulation, which is, in fact, nature's means of combating portal obstruction, it would seem that some form of omentopexy is indicated in selected cases as a measure supplementary to splenectomy. Because inclusion of a segment of the omentum in closure of the wound jeopardizes healing, I prefer to incorporate it in the abdominal wall, lateral to the incision for laparotomy. After separation of the several layers of the abdominal wall for 3 centimetres from the edge of the wound, a small incision is made through the peritoneum and posterior sheath of the rectus abdominis muscle, and a segment of omentum 14 to 20 centimetres is then drawn up through this opening and sutured. Similar incisions are made in the muscle and anterior sheath of the rectus abdominis, at successive levels, each lower than the preceding one, 2.5 centimetres or more apart, and the omentum is drawn through these, the distal 5 to 8 centimetres is then buried beneath the skin.

By bringing the omentum out in a steplike manner, conditions are established for the formation of new blood channels in each layer of the abdominal wall, and on account of the oblique course of the openings, the chances of troublesome herniation are minimized (Fig 1)

One or both of these procedures, ligation of the coronary vein and omentopexy, have been employed in conjunction with splenectomy in thirteen of the cases seen more recently, but there has not yet been sufficient time to permit estimation of their value in the prevention of recurrent hæmorrhages.

*Hæmolytic jaundice*—This condition may be defined as hæmolytic disease affecting primarily the spleen and secondarily the liver, characterized by varying degrees of anæmia, by acholuric jaundice, that is, jaundice with unaltered stools and urine, splenomegaly, microcytosis, and increased fragility with active regeneration of the erythrocytes. Two types of the disease have been described, the congenital and the acquired, distinguished chiefly

was interrupted by one or more attacks of "crisis," characterized by malaise abdominal pain, fever, increase in size of the spleen, deepening of the jaundice, and increase in anæmia. Not uncommonly, the crisis is mistaken for biliary colic, and operation is advised. Conclusive evidence of disease of the gall-bladder, with and without stones, occurred as a secondary complication in eighty-one cases (68.6 per cent of the series) and in twenty-three of these, operations on the biliary tract had been performed elsewhere, presumably without knowledge of the presence of the primary disease. In none of these cases were gall-stones found in the common bile-duct, although in several cases a direct van den Bergh reaction was obtained.

Operative data were suggestive of secondary affections of the liver in fifty-five cases. Cirrhosis of the liver was noted by the surgeon in seven cases, and in six cases ascites was found, but the condition of the liver was

Table 3

Splenectomy for hemolytic jaundice

Age by decades	Cases	Hospital mortality	Subsequent deaths	Living	Well	Fair	Poor
0 - 9	21		2	19	16	3	
10 - 19	20		2	17	13	4	
20 - 29	38	2	2	32	28	2	2
30 - 39	24	1	4	18	15	1	2
40 - 49	11		1	9	8	1	
50 - 59	4	1		3	2	1	
Total	118	4	11	98	82	12	4

not mentioned. In the remaining thirty-two cases, the liver was described as enlarged, congested, hard, or adherent.

On comparing the results of the operation in these cases with the results in cases in which the liver was normal or was presumed to be normal it would seem that the secondary affection of the liver exerted a decisive influence. The operative mortality was 5.4 per cent in the former group, as compared to 1.6 per cent in the latter, whereas the proportion of patients who survived the operation and who are living, is 80 per cent in the former group, and 90 per cent in the latter.

Evidence of the benefits of splenectomy usually becomes apparent within five or eight days after the operation, the jaundice then begins to fade and it disappears completely within two or three weeks. In many instances the patient is now free of jaundice for the first time in his life. Rapid and progressive improvement of the anæmia is also commonly noted before the patient is dismissed from the hospital. However, certain of the most char-

nose and uterus, to intractable hæmorrhages. One patient died as a result of cerebral bleeding.

The typical changes in the blood in these cases were (1) Reduction in the number of platelets, (2) prolonged bleeding time, (3) delayed retractility of the clot, (4) normal coagulation time, and (5) secondary anæmia with evidence of the normal regeneration of the erythrocytes. The capillary resistance test, indicating abnormal permeability of the capillaries, was positive in all cases in which it was employed.

Since the principal indication for splenectomy in hæmorrhagic purpura is a definite diagnosis, it is extremely important to distinguish this disease from others in which hæmorrhagic tendencies are common, notably, aplastic anæmia, hæmophilia, and acute leucemia. This usually can be readily accomplished by correlating the results of detailed examination of the blood with the clinical history. However, the diagnosis may at times be extremely difficult, and failure of an accurate diagnosis undoubtedly accounts for many of the poor results reported in the literature.

In but few diseases in which symptoms are so alarming are the beneficial results of operation so dramatic as in hæmorrhagic purpura treated by splenectomy. It occasionally happens that the patient is bleeding at the time of operation, and sometimes the hæmorrhage ceases before the patient is returned to his room.

An appreciable rise in the number of the blood platelets has been noted within twenty-four hours after removal of the spleen, and often by the third day the platelet count is within normal range. The thirty-nine patients who survived the operation are alive, and all but three are in good health. Giffin observed, in some cases, mild recurrence of hæmorrhage, which ceased following elimination of infected tonsils or teeth.

#### CONCLUSIONS

From these data it is evident that, contrary to the prevalent view of the hazardous nature of splenectomy, the operative results (67 per cent) compare favorably with those of other major abdominal operations, and in spite of the relatively common mistakes made in diagnosis, the conditions associated with disorders of the spleen and amenable to splenectomy can readily be identified, provided complete data concerning the blood are correlated with the clinical history.

Since the operative results in cases of splenic anæmia are largely contingent on the presence of secondary affections of the liver and portal obstruction, the need for early diagnosis and operation is apparent. Enlarged spleens, in the absence of definite etiology, should be considered as instances of the splenomegaly of potential splenic anæmia, and operation should be advised. However, clinical evidence of the presence of hepatic injury should not in itself be considered a contra-indication to splenectomy, since many patients in this group lived active lives for many years after removal of the

# ABSCCESS OF THE LIVER

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ABSTRACTS are herewith submitted of nineteen cases of abscess of the liver treated in the Emory University division of the Grady (Municipal) Hospital, during the five-year period, 1926-1931. The first fourteen are cases caused by the *endamoeba histolytica*, while in the remaining five cases pyogenic bacteria are the etiologic agents. All the patients were native-born Georgia negroes, and only one patient with amoebic disease ever lived outside the state. The clinical history suggests malaria as a causative factor in several instances, but all the amoebic cases were negative for this plasmodium. More than 50 per cent of the patients entering this hospital give positive blood Wassermanns. It so happened that only two of these patients had syphilis. During the same five-year period, among approximately the same number of white patients admitted to the hospital, 25,000, there were two cases of amoebic hepatic abscess.

A review of the cases of amoebic abscess in the series invites comment concerning the clinical aspects. It has been shown repeatedly that amoebic dysentery and abscess are not diseases confined to the tropics. The term tropical abscess, meaning amoebic abscess, should be discarded. Amoebic abscess also is regarded as being single, and pyogenic abscess as being multiple. One of these patients had multiple amoebic abscess, two patients had single pyogenic abscess. Males are more susceptible to the disease than females, in a proportion of 5 to 1, and in the state of Georgia the colored race is considerably more susceptible than the white race. Most authors mention alcoholic addiction as a predisposing factor in the etiology of amoebic abscess. Only one patient among these fourteen used alcohol excessively.

Only five patients gave a history of bloody dysentery preceding or accompanying abscess formation, and in but one patient could the amoeba be demonstrated in the stool. The *endamoeba histolytica*, or its encysted form, was recovered from the pus or the abscess wall in eleven of fourteen patients. The three other patients present such typical clinical findings of amoebic abscess that the diagnosis seems warranted. Sometimes amoebæ may be found in the first escape of fluid from the abscess cavity, or by scraping the abscess wall. Again they may not appear in the discharge until the second or third day after operation. In none of these patients was jaundice present although jaundice is not easily discernible in the black race.

Amoebic abscess of the liver is divided into the acute and the chronic form. There are typical examples of both kinds in the series, but three cases are described which might be placed in a third classification, the sub-



suspected The cough may be due to the pressure of the elevated liver against the diaphragm Harrington<sup>1</sup> reports five cases of amœbic hepatic abscess, in four of which the lesion was first diagnosed as thoracic rather than abdominal Two of the patients in the present group were operated upon twice for amœbic abscess, occurring in different parts of the liver at widely separated times

Rogers, (2), in his classical monograph on amœbic abscess, calls attention to the presence of the relatively low percentage of polymorphonuclear leucocytes This probably is true in the chronic form, in which only amœbæ are causative factors Although demonstrated bacteriologically in only two of these cases, in which staphylococci were found, it appears that acute abscess generally means mixed infection, and both the total leucocyte count and the percentage of polymorphonuclears are high

Rontgen examination of suspected hepatic abscess cases is not consistently helpful in the diagnosis The demonstration of an elevated diaphragm is valuable information, but sometimes it seems difficult to determine whether the pathology is below or above the diaphragm Several of these cases are reported as showing pleural or pulmonary lesions, as in Harrington's experience LeWald's<sup>3</sup> recommendation offers a solution of the problem A lateral thoracic rontgenogram always should be taken It brings out the complete curve of the diaphragm, and seldom fails to differentiate between disease below and above the muscle In some cases such pathologic conditions may coexist The aspiration of a liver abscess, and replacement of the fluid with lipiodol, furnishes a graphic rontgenogram of the abscess cavity One case in the series presented on percussion a large area of resonance just above the liver This was puzzling until the rontgenogram disclosed a collection of gas produced by a gas-forming organism from a ruptured hepatic abscess

The diagnosis of amœbic liver abscess would be made easier if the amœba could be found in the stools in more cases The history, symptoms and signs are variable, and often prolonged study of patients is necessary One sign always is present, if it can be established—an enlarged liver The problem then is to eliminate syphilis, malignant disease, cirrhosis and other causes of enlarged liver

Rogers protests against open operation in amœbic hepatic abscess, which he claims invites secondary infection and greatly increases the mortality He urges treatment by repeated aspiration This method may be indicated in abscess due solely to the *endamoeba histolytica*, if one can locate the involved area without exposing the liver In the majority of cases in this group, however, in which mixed infection was presumed to be present already, more radical and more certain surgical incision and drainage seemed to be the method of choice Usually the procedure should be carried out in two stages, as in operating upon lung abscess If this rule had been followed consistently in the present series, probably two deaths would have been avoided Since an amœbic dysentery the adequate administration of emetine

splenectomy performed two months previously for splenomegaly due to splentitis. These three abscesses were multiple, the colon *bacillus* being present in one case, and the streptococcus in the other two cases. Differential pre-operative diagnosis between liver abscess due to amœbæ and abscess caused by pyogenic bacteria, with negative stools, is rarely made, except in traumatic cases. Certainly, the prognosis is far less favorable in multiple abscess than in single abscess.

#### CASE REPORTS

CASE I—Male, aged forty-two. Admitted October 27, 1926. Four months before admission, the patient first noticed pain in the upper abdomen, which was followed in a few days by the rather sudden appearance of a mass in the region of the liver. At about the same time bloody dysentery appeared. He was weak, and apparently had lost considerable weight. The liver, or a mass continuous with the liver, extended to within 2 centimetres of the umbilicus. The mass was smooth, round and pulsating, but it was not expansile, and no bruit could be heard. It felt cystic rather than solid. Rectal examination showed marked redness of the mucosa, but no ulceration. Rontgen study reported deformity of the duodenum, due to pressure, and 4 centimetres' elevation of the right side of the diaphragm. Temperature 103°, pulse 85. Leucocytes 20,400, polymorphonuclears 62 per cent. The stools were found loaded with *endamoeba histolytica*. The examination otherwise was essentially negative. The diagnosis was amœbic abscess of the liver. Following the hypodermic administration of emetine hydrochloride grain 1 daily for three days, on November 5, under local anæsthesia, through a right rectus incision, a single cavity in the right hepatic lobe was emptied of 750 cubic centimetres chocolate-colored, odorless fluid characteristic of amœbic abscess, and tube drainage instituted. Amœbæ were not demonstrated in this fluid, the abscess wall was not scraped. Three days later amœbæ were found in the discharging pus. Alcresta tablets of ipecac were given the patient after the operation. January 7, 1927, the patient was sent home with normal temperature, and only a small drain in the wound. Three days afterwards he returned on account of fever, and swelling in the line of the incision. This was reopened, with further discharge of pus from the liver cavity. February 1, he was dismissed as cured. In May, 1931, he was readmitted to the hospital with the development of another amœbic abscess in a different portion of the right hepatic lobe. The patient was not very sick this time. The abscess was drained through resection of the ninth rib in the mid-axillary line. Amœbæ were demonstrated in the pus. The patient left the hospital in three weeks in good condition, returning to the out-patient clinic to be dressed.

CASE II—Male, aged forty-two. December, 1926, first noticed that his abdomen was swollen, but did not seem to be very sick, and was able to continue with his work. He may have had diarrhœa before this time, but was not certain. February, 1927, he had headache and nausea, and grew very weak. There was pain in the chest, and dyspnœa, but no cough nor night sweats. When he entered the hospital, September 6, 1927, his liver could be felt 10.5 centimetres below the costal margin. Temperature was normal, and did not reach 100° all the time he was in the hospital. Leucocytes 12,250, polymorphonuclears 59 per cent. He had been a heavy drinker. The rontgen diagnosis was fluid in the right chest. September 8, an aspirating needle was introduced through the ninth interspace, thinking the pleural cavity was being reached. Instead, the withdrawal of 3,400 cubic centimetres of thick brown odorless fluid caused the abdominal distention to disappear. The swelling gradually recurred, however, and fifteen days later, under local anæsthesia, an abscess in the right lobe of the liver was drained in one sitting, by resecting the ninth and tenth ribs. Three days later the encysted form of the *endamoeba histolytica* was found in the pus. The patient was dismissed, November 2, as cured.

sided, but returned in the same way in October, 1924, when she vomited frequently, and grew very weak. Again, she was comparatively well until September, 1926, when the pain appeared in the left side, but she thought the right upper abdomen was swollen. In January, 1928, she had dull aching in the epigastrium. She belched a great deal of gas, usually about two hours after eating. Upon entering the hospital, March 26, 1928, she had a mass reaching 10 centimetres below the costal margin. Temperature  $99.8^{\circ}$ , pulse 70, leucocytes 14,950, polymorphonuclears 63 per cent. Stools negative. The roentgenogram showed the right diaphragm elevated 8 centimetres. The roentgen diagnosis was tumor of the ovary or kidney. In a conference of the surgical staff, while most members thought the condition was liver abscess, the possibility of liver or pancreatic cyst or tumor was considered. April 11, under gas anaesthesia, through an abdominal incision, a hepatic abscess, with thick fibrous wall, was disclosed.



FIG 5



FIG 6

FIG 5—Liver abscess showing elevation of diaphragm  
FIG 6—Liver abscess injected with lipiodol outlining cavity in liver

in the right lobe, and 4,500 cubic centimetres chocolate-colored fluid removed. Encysted amœbæ were found in the pus. The patient died eight days after operation from peritonitis, with temperature  $107^{\circ}$ .

CASE VI—Male, aged twenty-six. This patient entered the hospital March 4, 1929, and died the next day without being fully studied. He gave a history of four weeks' illness, beginning with vomiting, colicky pains, daily chills, weakness and diarrhœa. Autopsy showed one large liver abscess, and several small ones. Amœbæ were recovered from the walls of the abscesses.

CASE VII—Male, aged thirty-six. Entered hospital November 12, 1929, with history of fullness in the epigastrium and shortness of breath for the preceding six months, getting progressively worse. He had epigastric pain which seemed to come one hour after meals, nausea and vomiting, and a productive cough, which did not show tubercle bacilli. The liver reached 8.5 centimetres below the costal margin. Temperature was  $101.4^{\circ}$ , pulse 100, leucocytes 9,500, polymorphonuclears, 74 per cent. Roentgenogram showed the right diaphragm 5 centimetres above normal. Gastro-intestinal

inesthesia first-stage thoractomy performed April 22, second stage, with evacuation of typical amoebic fluid April 24 amoeba found in discharging pus May 21, patient sent home as cured

CASE XII—Male, aged nineteen Sickness started January, 1930, with pain in upper abdomen fever night sweats, prostration, no chills Admitted May 20, with temperature 100°, pulse 140, leucocytes 15,000, polymorphonuclears 81 per cent The liver was tender, 9 centimetres below costal border No history of dysentery, stools negative Rontgen report was right diaphragm high Diagnosis—Amoebic abscess of liver May 27, under local anæsthetic, pleura sutured to diaphragm through the ninth rib May 28, abscess in right lobe of liver emptied of 500 cubic centimetres chocolate-colored fluid Numerous amoebic cysts disclosed The patient's pulse and temperature dropped to normal a few days after the operation, and remained normal June 20 discharged as well

CASE XIII—Male, aged thirty-eight Patient came to hospital October 6, 1930, apparently very ill, temperature 101°, pulse 120 The liver was very tender, and the liver dullness greatly increased, extending 10 centimetres below the costal margin The patient's sickness began suddenly three weeks before admission, with pain in the right shoulder, no nausea or dysentery The diagnosis was liver abscess No rontgen work or blood counts were done prior to the operation, which was performed twenty-four hours after he entered the hospital Under novocaine anesthesia, through excision of segments of the eleventh and twelfth ribs, an enormous ruptured hepatic abscess was found, containing thick, brownish-yellow pus, with foul odor Ample drainage was provided The cystic form of the amoeba was found a few days later Following operation the patient ran a septic course, with leucocytes varying from 15,000 to 32,000, and the polymorphonuclears from 79 per cent to 94 per cent November 20, rontgen examination following lipiodol injection into sinus, showed abscess cavity in liver December 21, the patient left the hospital as improved

CASE XIV—Female, aged seventeen She entered the hospital April 9, 1931, with a history of three weeks' illness marked by high fever and bloody dysentery The abdomen was very tender, rigid and bulging, the liver reaching 7 centimetres below the costal rim Pulse 140, temperature 102°-104°, leucocytes 24,000, polymorphonuclears 85 per cent, erythrocytes 1,150,000, hæmoglobin 35 per cent She had night sweats, nausea and vomiting The rontgen diagnosis was diaphragmatic pleurisy, the right diaphragm being elevated Wassermann three plus Bloody stools negative for amoebæ April 15, under novocaine anesthesia, through a right rectus incision, 750 cubic centimetres foul, greenish-yellow pus were obtained from liver abscess Amoebæ were demonstrated The patient continued very sick, developed left lower lobar pneumonia, and died April 18

CASE XV—Male, aged twenty-five Patient entered the hospital December 7, 1927, in a delirious condition Impossible to obtain history Temperature 102°, pulse 130 Died the next day Autopsy showed multiple abscesses of the liver, *B. coli* present

CASE XVI—Male, aged thirty-nine Patient had chills and fever in Jamaica in boyhood In January, 1915, he had severe cramping pain in left upper abdomen, which lasted one year, and later recurred Two days before admission, May 27, 1928, he experienced another pronounced attack There was a tumor mass in the left upper abdomen, diagnosed as enlarged spleen or kidney Malarial parasites could not be demonstrated in the blood Temperature 103°, which dropped to normal after operation Wassermann negative May 22 splenectomy was performed under gas-ether anesthesia The spleen weighed 1350 grams and measured 10 by 20 centimetres The diagnosis was splenomegaly due to splenitis The wound became infected, the patient ran considerable temperature, but apparently got well and left the hospital June 19, with a small draining sinus July 2, 1928, the patient was readmitted with dyspnoea, swollen feet and liver extending 5 centimetres below the costal border The temperature was 101°, then became subnormal Hepatic abscess was diagnosed, but aspiration

# THE SELECTIVE SURGICAL TREATMENT OF DIAPHRAGMATIC HERNIA

BY CARL A. HEDBLUM, M.D.

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DIAPHRAGMATIC hernia is a protrusion of abdominal contents through an abnormal opening in the diaphragm which results from imperfect development, anatomic weakness or trauma. Of 1,003 cases reported in the literature since 1900, nearly one-third were classed as congenital, a little more than one-third as acquired after birth, and about one-third followed trauma. Most of those of the acquired type were œsophageal hiatus herniæ.\*

In each of these etiologic types there are many anatomic and clinical variations which are of much importance to treatment. The presence or absence of a sac, the position and size of the ring, and the varying hernial contents constitute important anatomic differences. The strangulated and non-strangulated hernias represent the most definite clinical types, but lesser disturbance of physiologic function, age and general condition of the patient are important factors bearing on indications for surgical treatment and on the choice of operative procedure.

As reported in the literature, a sac is present in less than a quarter of the cases of congenital hernias, in more than 95 per cent of those acquired after birth, but is rarely present in hernias due to penetrating injury or violent blunt trauma. If a sac is present and is not incised pneumothorax does not result if the hernia is repaired through a laparotomy approach. On the contrary, if there is no sac, a pneumothorax develops through a laparotomy as well as through a thoracotomy approach.

If a congenital hernia is small the opening is most often posterior, if larger it is usually postero-lateral, if very large a sickle-like segment of the diaphragm may be found antero-laterally or there may be complete absence of the hemi-diaphragm. The predominatingly posterior location of a small opening is due to the fact that it is the site of the pleuro-peritoneal canal which is closed last by the developing diaphragm. A congenital hernia therefore typically involves the posterior portion of the diaphragm which is least accessible by a laparotomy. The opening may be too large for closure except by the aid of a plastic. In case of a sub-total or total defect a collapse of the chest wall may be a necessary preliminary operation.

Acquired hernias develop chiefly at the œsophageal hiatus, of which more than two hundred cases diagnosed roentgenologically, are reported in the recent literature. The hernia opening as a rule is small, easily approached and identified by thoracotomy but not infrequently is very difficult to expose.

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\* For tables and complete bibliography see chapter on Diaphragmatic Hernia by author in Lewis' "Practice of Surgery," vol. 1, 1930.

relatively slight indication for reduction or repair unless enough of the liver were herniated to interfere with respiration

Adhesions of the hernia contents are most apt to develop in the chronic traumatic type. Absence of adhesions can be determined clinically only if the hernia contents can be seen in and out of the pleural cavity roentgenologically

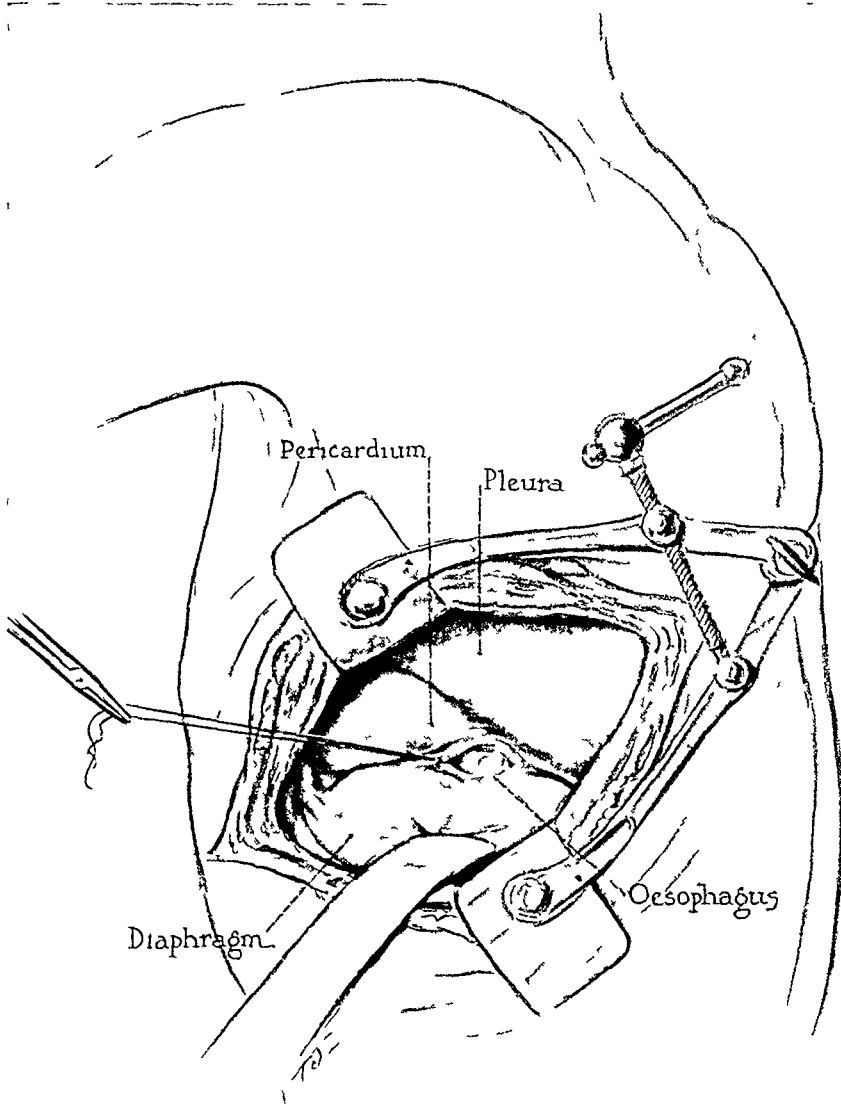


FIG 1—Seventh interspace thoracotomy approach to oesophageal hiatus

Herniation of a small part of the stomach through the oesophageal hiatus often can be produced by placing the patient in a horizontal or head-down position while under fluoroscopic examination. Such demonstration of a hernia is proof of the absence of adhesions.

Age is an important factor in consideration of treatment. Of 210 non-traumatic cases under one year of age, 158 (75 per cent) died before the

ing, but other procedures find their indications as emergency life-saving measures or as preliminary to repair.

The most important emergency operation is drainage of an acute intestinal obstruction. This may be by a cæcostomy, appendecostomy, colo-colostomy or enterostomy, according to the individual indications. Truesdale

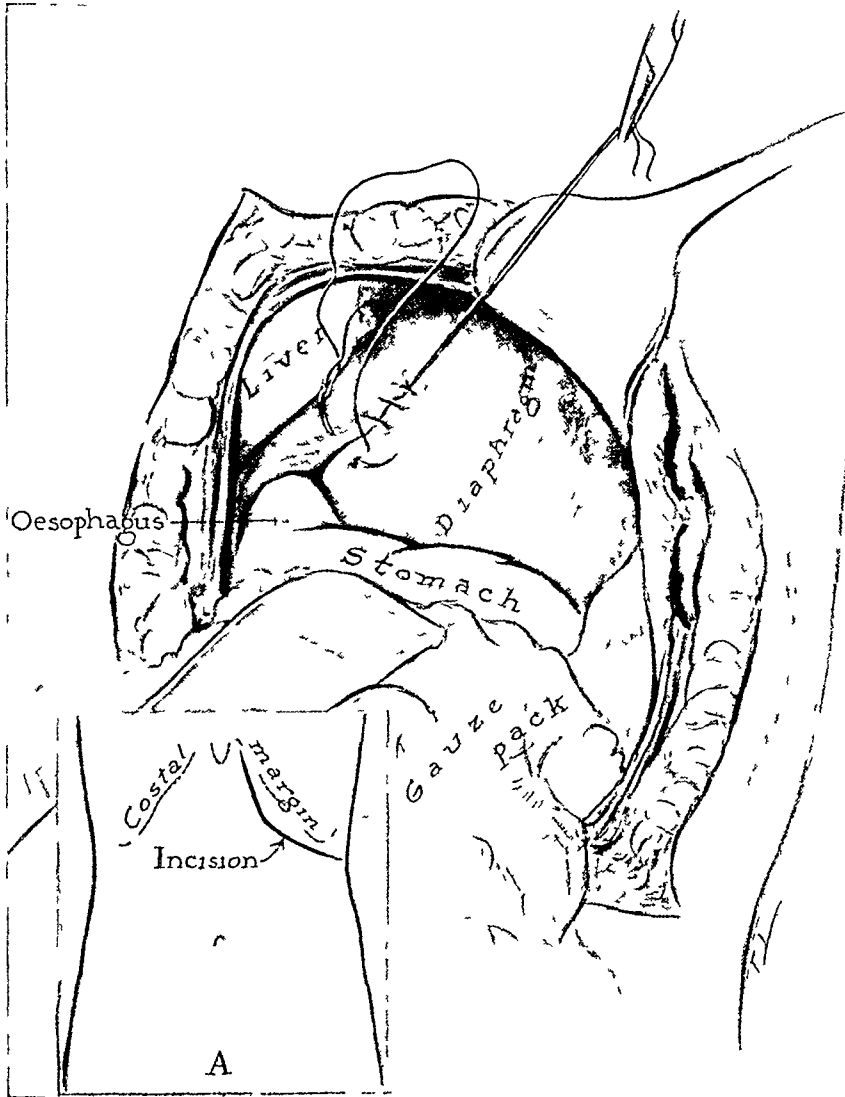


FIG 2—Left costal margin approach to oesophageal hiatus for repair of diaphragmatic hernia. The ligament of left lobe of liver has been cut and left lobe retracted for better exposure. Rectus muscle is split longitudinally to near the level of the umbilicus then sectioned transversely to avoid extensively damaging innervation.

has called attention to the value of dealing with an acute obstruction before attempting to repair the hernia. Several cases are reported in which all symptoms disappeared following colo-colostomy and no further treatment was necessary. If the bowel is gangrenous drainage at the site may avert a fatal issue.

approach for repair of a hernia. However, modern equipment for thoracic surgery includes positive pressure gas anaesthesia apparatus which largely obviates any danger from a wide open pneumothorax incident to a thoracotomy approach.

The repair of the hernia usually may be accomplished either through a laparotomy or a thoracotomy exposure. Occasionally both the pleural and peritoneal cavities must be opened to affect a reduction and repair. For this purpose separate incisions or a combined thoraco-laparotomy incision may be made. There exists considerable difference of opinion as to the relative merits of these various operative routes, as such.

The criteria on which they have been compared have been the relative technical difficulties and mortality rates.

There can be no doubt but that the identification of a hernia not previously diagnosed, and its reduction and repair is facilitated by a thoracotomy approach. Thus, in a series of 215 cases in which laparotomy was performed, the hernia opening was sutured in 129 (60 per cent), reduced but not sutured in thirty-seven (17.2 per cent), not reduced in thirty-three (15.3 per cent) and not found in sixteen (7.4 per cent).

Of 167 cases in which thoracotomy was performed, the opening was sutured in ninety-one (90 per cent), not sutured in six, not reduced in three and not found in seven. Of ninety-one cases in which combined thoraco-laparotomy was done the ring was sutured in eighty-one (87 per cent), not sutured in three and not found in seven.

According to figures usually cited the mortality rate following laparotomy is much higher than following thoracotomy, but this difference seems to be due to the relatively much larger proportion of obstructed cases operated by laparotomy. Of 467 cases 246 were operated by laparotomy with ninety-six deaths (34.9 per cent), 132 were operated by thoracotomy with twenty-six deaths (19.7 per cent), eighty-nine were operated by a combined laparotomy and thoracotomy and of these twenty-eight (31.4 per cent) died. Among these same 467 cases 149 were obstructed. Of these 100 were operated by laparotomy with sixty-nine deaths, twenty-three by thoracotomy with four deaths (17.3 per cent), twenty-six by a combination of both routes, with seven deaths (27 per cent). There were 318 non-obstructed cases. Of these 146 were operated by laparotomy with twenty-seven deaths (18.5 per cent), 109 by thoracotomy with twenty-two deaths (20.2 per cent), and sixty-three by the combined route with twenty-one deaths (33.3 per cent). It would seem probable that the patients with intestine obstruction who represented the poorest surgical risks were almost without exception subjected to a laparotomy. The increased mortality in these cases with perhaps a few exceptions would be due to the obstruction as such rather than to the operative route.

The uniformly high mortality rate following a combined thoracotomy and laparotomy is probably due in most cases to shock and an increased incidence of post-operative complications.



long standing, especially of the traumatic type, and difficulty with reduction may be anticipated in obese patients and those with strong abdominal muscles as contrasted with the flabby abdomen of patients who have lost much weight, or in case of women who have borne many children

In case a laparotomy is the primary approach and reduction is impossible, or seems unsafe on account of adhesions, the abdominal wall may be closed temporarily and a secondary thoracotomy may then be performed. Or in case no difficulty with reposition of the viscera is anticipated the thoracotomy may be deferred to a later date. Similarly, in case a thoracotomy is first performed an immediate secondary laparotomy is indicated if there is serious difficulty with the reduction of the herniated viscera from above.

There can be no doubt that a combined thoraco-laparotomy facilitates exposure to the hernia opening, reduction and repair but, as stated, the mortality has been much higher than where the other routes have been used.

Special procedures, in cases with hernia openings that it has been impossible to close directly, besides plastic operations on the chest wall mentioned above as preliminary operations, include the use of muscle and fascia for direct repair and obturating the opening with an abdominal viscus. Keller has described a method involving the use of a portion of the latissimus dorsi muscle, Truesdale has used a fascial flap and Sauerbruch has sutured the diaphragm to the chest wall at a higher level than that of its normal attachment.

In case of a thoracic stomach in which only the cardiac portion of the viscus lay above the hiatus, it may be possible to transplant this portion of the stomach to the level of the diaphragm more laterally, as was done by Hybbinette. The opening has been obturated by suturing into it the adjoined portion of the stomach or spleen. In other cases an attempt has been made to prevent the stomach from herniating by suturing it to the abdominal peritoneum and to the diaphragm. Recurrences usually follow such methods. If the hernia opening is inaccessible by laparotomy a thoracotomy should be performed at the same time or later.

A simple procedure following reduction and repair of the hernia that may be life-saving is to reduce a surgical pneumothorax to a minimum. This may be accomplished by inflating the lung with the positive pressure gas anaesthesia apparatus before the pleural cavity is completely closed or afterwards by aspirating the air. The latter can be performed best with a pneumothorax apparatus by reversing the system, using the monometer as a guide in withdrawing enough air to produce a negative intra-pleural tension equivalent to 4 to 10 cubic centimetres of water pressure. This procedure relieves the mediastinum and so the other pleural cavity of the atmospheric pressure introduced by the pneumothorax. This, plus increased intra-abdominal pressure due to the restoration of herniated viscera into the abdominal cavity may reduce the vital capacity beyond the patient's power to compensate, and may also hamper circulation greatly. Reinflation of the collapsed lung in itself increases respiratory capacity and lessens the hazard of a complicating post-operative empyema.

# LATE RESULTS OF SURGICAL AND MEDICAL TREATMENT OF CHRONIC CHOLECYSTITIS

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WE HAVE endeavored in this follow-up study to record the late results obtained from surgical treatment and from medical treatment of patients suffering with cholecystitis. In this effort we have selected those patients whose histories were written and on whom a diagnosis of gall-bladder disease was made from five to fifteen years ago. In order to draw some rather definite conclusions from this investigation, we have used a limited group of patients, selected because they were suffering from well-defined chronic cholecystitis without complications. Thus those patients with acute cholecystitis, empyema, jaundice, or carcinoma have not been included. The histories, which were written five or more years ago, have been reviewed, and questionnaires have been sent to the patients, and a number of personal interviews have been held, particularly with patients who have not received relief.

This group of patients have not been particularly benefited by the advance in the knowledge of gall-bladder disease which has been made recently. Few of these people had the aid of cholecystography, which, while not necessarily increasing our accuracy in diagnosis, is certainly a great aid in arriving at more definite conclusions. Because of our added knowledge of the factors influencing the functions of the liver and biliary passages, the immediate hospital mortality of 6 per cent noted in this group would have been reduced, we find, had these patients been operated upon in recent years to less than 3 per cent. We now know that a diseased gall-bladder is almost always accompanied by inflammatory changes in the liver and in the biliary ducts. A damaged liver functions best with a high glycogen reserve, and ingested glucose gives a more satisfactory rise in blood-sugar than that given intravenously (Ravdin). We know that jaundiced patients have a low glycogen reserve and that when they are dehydrated the liver takes up and restores the glycogen content to normal very slowly. Mann has gone further, since these observations were made, in proving that animals with damaged livers are kept alive much longer on a carbohydrate than on a protein diet. Because formerly these facts were not known, many of the patients in this group were deprived of the benefit of careful selection of the time for operation. When the liver is carrying a high glycogen reserve and when diet has been controlled to such an extent that the necessity for detoxification of protein by-products by the liver is at a minimum, the operative risk is least.

Again, any change of mechanism, whether due to hepatic cell damage or to chemical activity, which depletes the liver of its glycogen reserve increases the operative risk.

ence of a hyperacidity to make a diagnosis of cholecystitis on a patient presenting a history of chronic indigestion

The tabulation of the condition of the gastric acids in this series, with the number of cases and their percentages, was as follows

98 cases in which there was no free acid	24.3 per cent	} 55.7 per cent
126 cases in which the acids were low	31.3 per cent	
151 cases in which the acids were medium	37.5 per cent	
27 cases in which the acids were high	6.7 per cent	

#### THE RESULTS OF SURGICAL AND MEDICAL TREATMENT IN 200 CASES OF CHRONIC GALL-BLADDER DISEASE

There have been 100 surgical patients and 100 medical patients studied. It is hoped that by a comparison of the degree to which each series of patients has obtained relief after a period of at least five years, a more exact comprehension of what each method has to offer in the way of therapeutic results may be arrived at. As stated before, these cases were so selected that they represent a consecutive series of patients suffering from chronic gall-bladder disease. In the surgical group of patients it was not difficult to select this series, but the manner of selection of a comparable medical series presented more of a problem. First the records of all patients who had received a diagnosis of chronic cholecystitis were carefully studied. Those which did not have associated upper abdominal disease were classified into four groups. In Group I were placed the cases that anyone would concede to be proved diagnoses. Either the gall-bladder had been found at operation for other abdominal disease to be unmistakably pathologic, or, as was more frequently the case, a perfect history of classical gall-bladder disease was obtained. In Group II were placed those cases in which cholecystitis was obviously present, but in which actual proof such as visibility of stones or history of painful jaundice was lacking. In Group III we have placed two classes of cases. The one class consists of those patients in whom there was present at times severe abdominal pain, which, however, was either not described in sufficient detail or was atypical or else occurred acutely only once, although it was presumably biliary colic. The second class consists of those patients suffering from dyspepsia of a reflex type, but not accompanied by colic or other objective evidence of biliary disease. Finally in Group IV were placed those cases in which the diagnosis of chronic cholecystitis was made upon a suggestive history without further objective evidence of gall-bladder disease, in which, however, disease of the stomach and duodenum had been ruled out. Group IV manifestly contains the greatest number of errors in diagnosis, and consequently this group has been omitted from the study. The remaining three groups were handled separately, but, as there seemed to be no significant variations in their therapeutic results, they are combined in the diagrams to be shown and in the figures which will be given.

condition of digestion, the amount of gas, the presence or absence of colic, and the actual condition in regard to food selection

The medical series studied was interesting for the fact that the patients could be divided into three groups. One-third of the patients, because of continual pain, dyspepsia, gas, and belching and in some cases because of the development of an acute condition, were operated upon. The next third continued to have the symptoms, without relief from dietary control or medicine, and should have been operated upon. The remaining third were completely relieved of symptoms following medical treatment over a period of one to six months.

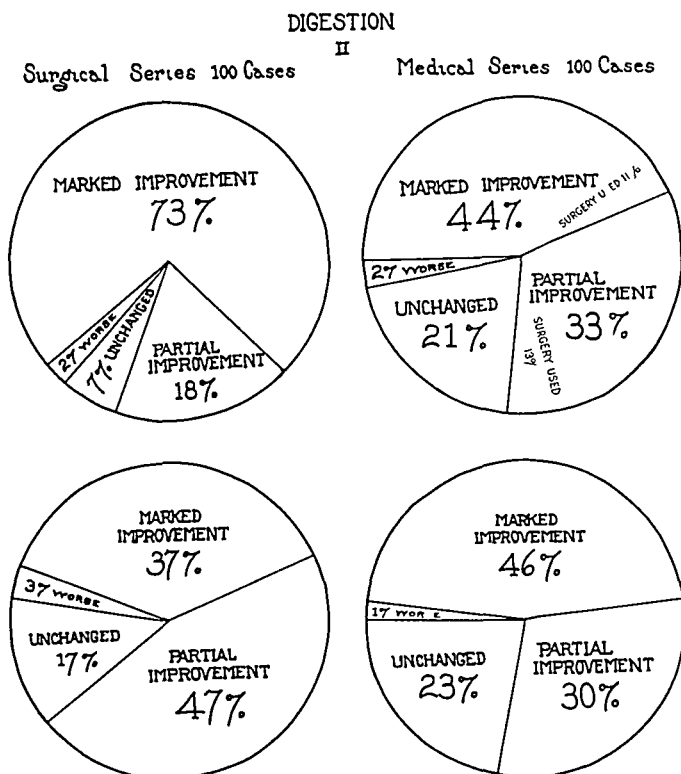


FIG 2

In the surgical series we find the following results. Regarding the relief of the symptom of pain by cholecystectomy, 83 per cent considered that the operation had relieved 75 per cent or more of their previous complaint, and 56.2 per cent stated that they had been completely relieved of all their old symptoms. Thirteen per cent continued to have symptoms as before, and 4 per cent had no relief. Of the four patients who answered that they had received no benefit at all following their operation, the gall-bladder in two cases was found markedly diseased, in one case the gall-bladder was white, and in the fourth case the patient was a marked neurasthenic. In none of these cases were stones found at operation.

Dyspepsia brings more patients with disease of the gall-bladder to the physician than any other complaint. Consequently the degree of relief of

they were worse in regard to food selection than they had been previous to the removal of the gall-bladder

Colic, which is considered a common symptom of patients with disease of the biliary tract, occurred in 18 per cent of the patients before surgical and medical treatment had been instituted. We find that 17 per cent still reported colic after surgical treatment, but that most of these patients had only one or two attacks and these in the first year following their operation. Five years ago we were not draining the common and hepatic ducts nor investigating for stones as often as we are today. This may be the reason for this

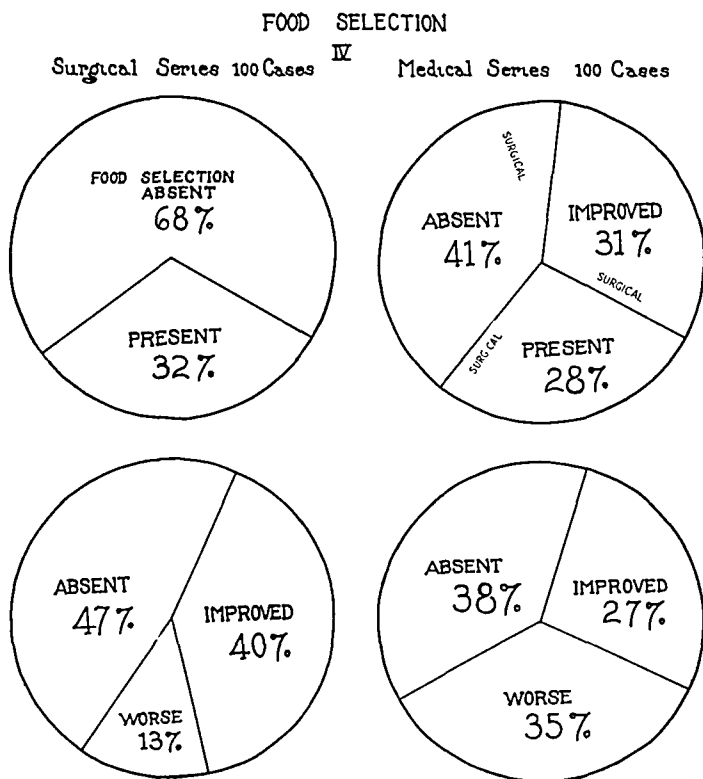


FIG 4

rather high percentage of patients having colic following their operation. The exact cause of gall-bladder and duct colic not due to calculi has not yet been definitely established, as many of these gall-bladders and ducts did not contain stones, only 45 per cent of the total series being found at operation to have stones.

#### CONCLUSIONS

(1) One-third of the patients treated medically came to operation from three to five years after diagnosis was made, one-third, because of the continuance of their symptoms, should have come to operation, and one-third under medical management became symptom free.

(2) Patients who have allowed their gall-bladder symptoms to go on for a number of years until their gastric acids have become low or absent, with

# TUBERCULOSIS OF THE ŒSOPHAGUS

REPORT OF A CASE WITHOUT ACTIVE TUBERCULOSIS ELSEWHERE

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TUBERCULOSIS of the œsophagus occurs rather infrequently, and it is still more rarely recognized. Most of the diagnoses were made at autopsies as accidental findings in patients who died of tuberculosis. In the literature no case is reported in which the lesion of the œsophagus was not accompanied by advanced pulmonary or intestinal tuberculosis. The following case is of interest because the œsophageal lesion was the only active tuberculous focus that could be found in the patient.

H N, a man, sixty-nine years old, stated that he had never been sick until about three months ago, when swallowing became more difficult than usual. Some ten weeks before I saw him he began to regurgitate his food within fifteen minutes after deglutition. Soon after, all solid food came back immediately, even butter and fat would not go down, only milk and soup. He complained of nothing else, but he lost over twenty pounds in two months, most of it in the last two weeks. He was in the Fifth Avenue Hospital from August 14 to September 5, 1930. Rontgenograms taken there August 18 by Doctor Cole showed obstruction at the lower end of the œsophagus. In most of these pictures the end of the œsophagus looked like a blind pouch with a smooth outline, as in cardiospasm (Fig 1). Doubtless cardiospasm had been present when those pictures were taken, but one of them (Fig 2) showed the condition when the spasm let up revealing an irregularity of the outline for about one and one-half inches further down, not unlike the appearance in carcinoma. While at the hospital, his lungs were examined, and a few moist rales at both bases posteriorly were found, otherwise the lungs were clear. The probable diagnosis of cardiospasm was made. The patient was discharged with the advice to have an œsophagoscopic examination. This was made some time later by Doctor Oberrender, of the Lenox Hill Hospital, who saw a tumor resembling a carcinoma of which he removed a specimen for biopsy. The patient was referred to me by Doctor R. Donald Beck, September 30, 1930. By that time his malnutrition was extreme, and I advised him to reenter the Fifth Avenue Hospital and to submit to a gastrostomy, no matter what the pathologic examination might reveal. He was readmitted October 3, and, in the meantime, the report by Doctor Rohdenburg, director of the laboratories of the Lenox Hill Hospital, established the fact that the lesion was tuberculosis, the picture presenting a tubercle composed of a group of giant cells surrounded by endothelial proliferation which in turn was infiltrated with round cells. No evidence of malignancy was found.

On admission the patient was extremely emaciated, had extensive bed sores at the sacrum and both hips, and appeared as though he was doomed to die in a few days. Therefore, regardless of what other treatment might subsequently be decided upon, the indication for feeding him through a gastric fistula was evident.

On October 4, 1930, I performed a Witzel gastrostomy under infiltration with  $\frac{1}{2}$  per cent novocaine. Through a left rectus incision an exploration was first made. A finger introduced into the hiatus of the diaphragm felt an uneven thickening on the right side of the abdominal œsophagus and the lower end of the thoracic œsophagus extending over a distance of about one and one-half inches. The feel of this was that of

how little the physical signs varied from the normal. The sputum contained no tubercle bacilli. After the operation the patient coughed somewhat more, but the examination of several specimens of sputum were again negative for tubercle bacilli. A roentgenogram of his lungs (Fig 3) shows a slight haze at the right apex, on which the report was as follows: "Old fibrotic lesion in the right apex. This has the appearance of a healed tuberculous process



FIG 3—A slight haze at the right apex interpreted as possibly the seat of a healed tuberculosis

Lungs otherwise clear." Further than this the expert opinion would not commit itself, and it seems that this opinion should be accepted, although the patient was entirely unaware of ever having been sick.

Heretofore no case of tuberculosis of the œsophagus has been recorded except in patients with advanced tuberculosis elsewhere. In this case there was positively no active tuberculosis in any other part of the body, much less an

alypin, stovaine, and oithoform have also been employed. Bromide, valerian and cannabis indica have been used to counteract the accompanying spasm. To the local remedies I would add the swallowing of barium paste, such as is used in X-ray examinations, which has a soothing effect. The local treatment through the œsophagoscope begins with preliminary mechanical cleansing and is followed by one of various kinds of applications, such as argentic nitrate 5 per cent, lactic acid half strength up to full strength, or iodoform. Guisez cured two cases with lactic acid. The use of radium might also be considered. Where a stricture exists, dilatation is permissible only if the ulcerations are not deep. Gastrostomy is indicated in cases of tight stenosis and in those where the analgesic treatment of the ulcers fails to enable the patient to take sufficient nourishment.



which is his life and try to develop new fields of interest in which he is not truly interested, and so shorten a life which is no longer stimulating

Before stopping my operative work I visited the clinics of the younger men, and I was convinced that the older man unconsciously loses something of handicraft, something of ready response to operative emergencies. When this became plain to me I was happy to turn, in the interest of the profession that I love so well and of the patients who had been my first thought, from an active surgical career to that of surgical advisor, that I might give to the younger surgeons such of value as I had, and to the patient the benefit of my experience. I have found great satisfaction in what is a change in direction rather than a giving up of my work, in a usefulness which is as delightful as unexpected and which will satisfy me to the end.

As I see the younger men picking up the torch and carrying it on, I realize that scientific truth which I formerly thought of as fixed, as though it could be weighed and measured, is changeable. Add a fact, change the outlook, and you have a new truth. Truth is a constant variable. We seek it, we find it, our viewpoint changes, and the truth changes to meet it.

There are many recompenses in a seventieth birthday. I look through a half-opened door into the future, full of interest, intriguing beyond my power to describe, but with a full understanding that it is for each generation to solve its own problems and that no man has the wisdom to guide or control the next generation. It is a comfortable feeling, to be interested in what is to happen, but in bringing it about to be in no way responsible.

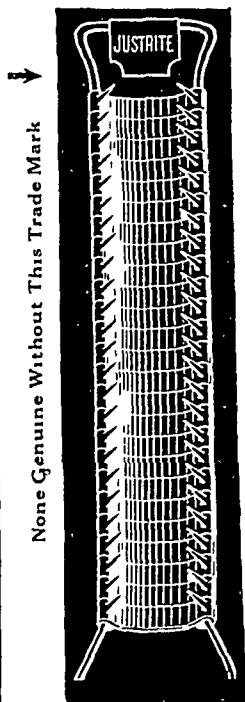
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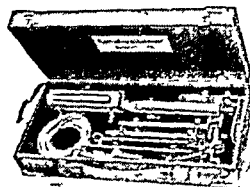
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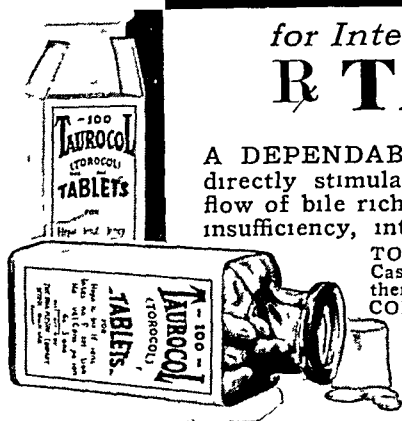
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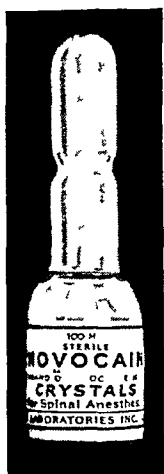
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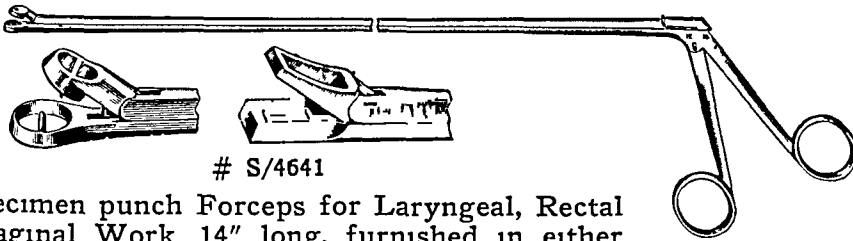
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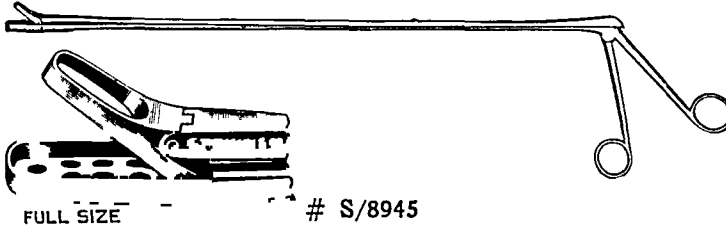
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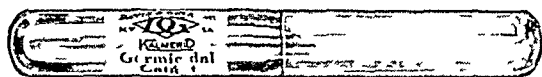
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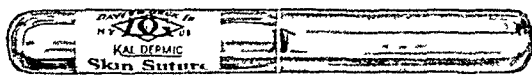


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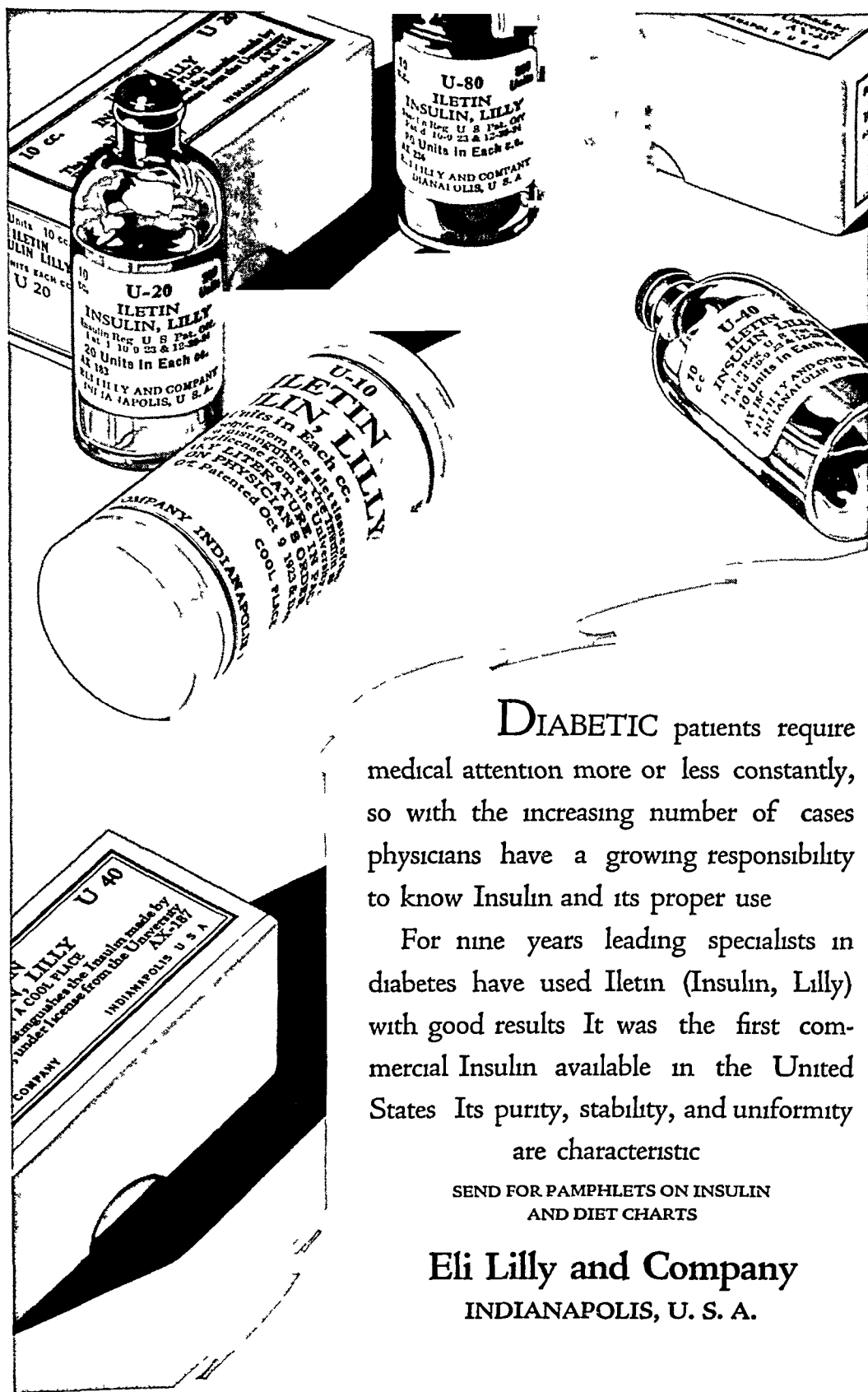
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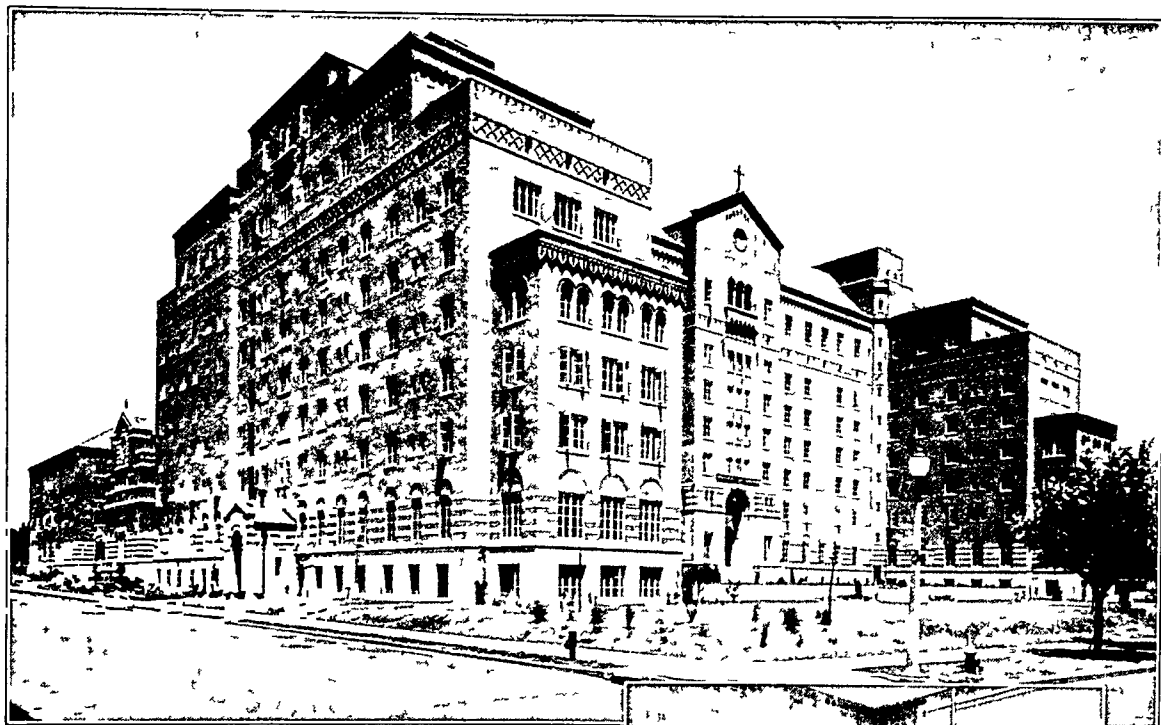


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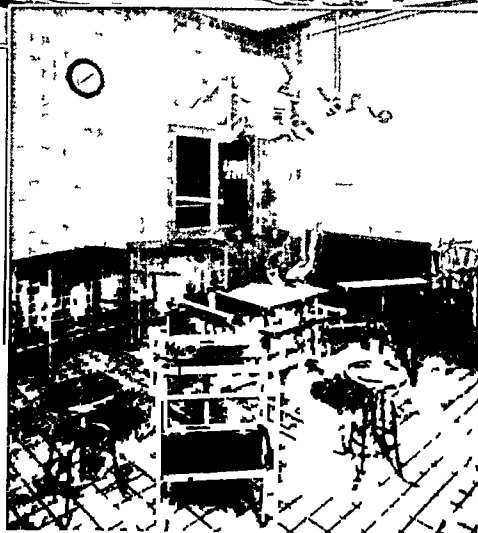
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"The poor sufferer had been examined by Sir Astley Paston Cooper, also by most of the medical men of this neighborhood, but he derived no benefit from the treatment recommended." At Sir Astley Cooper's suggestion, it was treated by the passage of bougies. Purton continues "On withdrawing the probang, I was a good deal alarmed by the degree of force by which it was retained fearing lest the cardiac orifice might be lacerated. By gradual, but considerable repulsive force being used, it was at length withdrawn, and, on its passing the orifice, it made a report so loud as to alarm the bystanders."

Subsequent writers have added nothing to the description. None have shown a better dramatic sense.

The next report was by Hanney in 1833, in the *Edinburgh Medical and Surgical Journal*.



FIG 1—X ray of infant which shows the opaque meal has entered the first part of stomach. Normal cardiac orifice dilated œsophagus. The meal was immediately rejected by a violent contraction of œsophagus.



FIG 2—Showing typical dilatation and narrowed œsophagus at level of diaphragm. Opaque fluid has partially entered œsophagus. Case not operated upon.

There seems to have been some general interest in 1840, for three separate reports are to be found in that year by Rokitausky, Delle Chiago, Fano, and Lindau. M. Curveillier's atlas in 1843 a picture is shown illustrating the disease. By 1877 Zeuker and Ziemssen could collect reports of eighteen cases. Neuman's series of papers in 1900 give the first comprehensive discussion of the subject, symptoms, methods of diagnosis, pathology and treatment. He found, up to that time, seventy cases. They are discussed under the title "Ein fach gleichmassige Erweiterung der speiserohre."

Following this case, reports appear rapidly in the medical journals, so that Theiding in 1921 collected 315.

Beyond this it is unnecessary to go, to show that the disease is frequent enough to be important as well as interesting. It is not far from the truth to say that next to cancer it is the commonest disease of the œsophagus.

By idiopathic dilatation of the œsophagus is meant a considerable dilata-

angle at its junction with the stomach. That is termed the cardiac notch. On the mucosal surface the notch is marked by a fold of mucosa and submucosa called the cardiac valve, though of itself it has no valvular action. The right border of the œsophagus is continuous with the lesser curvature of the stomach. The passage from the œsophagus to stomach is further marked by the change from the squamous epithelium of the œsophagus to the columnar of the stomach. The average length of the tube is 25 centimetres, though it varies from 5 to 10 centimetres from this. The diameter, empty, is from 2.3 centimetres at the cricoid cartilage to 2.6 or 3 centimetres at the widest. It is normally about 2.5 centimetres where it passes through the diaphragm.

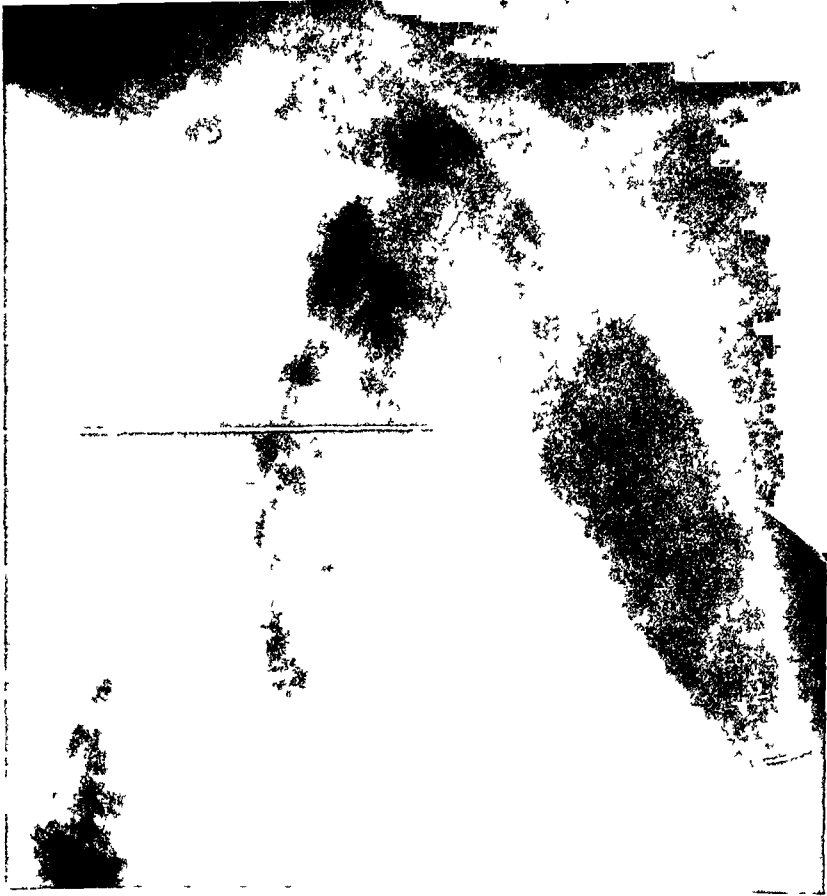


FIG 5—Case I. Four and one half years after operation œsophagus narrow, normal width but still fills to 6 inches before opaque fluid begins to enter stomach.

The upper orifice is formed by the lower fibres of the inferior constrictor muscle and belong more to the pharynx than to the œsophagus. The anterior lip is thin and attached to the cricoid. The posterior lip is formed by a band of striped muscle which, on contraction, closes the opening against the cricoid. The muscular wall of the œsophagus consists of two layers, an outer longitudinal and an inner circular. The longitudinal fibres arise as a tendon, one quarter of an inch wide, from a vertical ridge on the back of the cricoid. This gives rise to two muscular bands which are at first on the front of the organ, then diverge to pass down each lateral aspect, and gradually become a continuous muscular coat.

This arrangement is overlapped by the inferior constrictor of the pharynx, or

From the standpoint of this paper the only physiological interest is the act of swallowing

The description is drawn largely from *Handbuch der Normalen and Pathologischen Physiologie*

There have been three main theories relative to the passage of food through the œsophagus First that it passed by peristaltic action, second that it is squirted by the action of the pharyngeal muscles through a rigidly held tube, and third that it passes

through, in men, by gravity and by its weight overcomes the cardiac sphincter

This latter theory is of particular interest as it affects the understanding of the mechanics of idiopathic dilatation

It can readily be shown that all three play a part It is easily understood that there is a squirt action of the pharyngeal muscle constrictors, but that both the peristaltic action and the weight of the food play a part, is made clear, when the rates of passage as between fluid, semifluid and solid, are compared in the upright and the head-down position In the upright position, fluid passes almost continuously into the stomach through a rigidly held œsophagus and an open cardia, semifluid almost the same but more slowly, while solid food takes an appreciable time and can be seen to pass as a Bolus as by a peristaltic wave In the reversed position a single swallow stays in the upper end of the œsophagus and successive swallows gradually fill the tube toward the cardia, while solid food is still propelled as by a peristaltic wave into the stomach The observation that fluid, in men in the upright position, flows by gravity through the œsophagus into the stomach presupposes the fact that the cardia is held open and offers no opposition to its passage

The act of swallowing though initiated as a voluntary act becomes, during its execution, the swallowing reflex As has been mentioned, the œsophagus is supplied by both vagus and sym-

FIG 6—X ray of dogs œsophagus ten days after cutting of both vagi No food entered stomach. Œsophagus widely dilated and filled with water and food

pathetic nerves, but what part the sympathetic plays is not definitely known and the usual antagonism of the para and sympathetic has not been demonstrated The matter is further complicated because the vagus holds both inhibitory and motor fibres nor can a peristaltic wave be initiated by stimulation of the œsophagus at any one point as it can in other parts of the intestine Stimulation of the central end of a divided vagus while the other is intact results not in peristaltic waves but a contraction of the whole muscles The peristaltic waves are none the less controlled by the extrinsic nerves, and the orderly sequence of the movements of the swallowing reflex are regulated through a medullary centre



small, or pencil-like. It is this subdiaphragmatic portion which is of the greatest interest.

Out of 104 cases seen at operation or post-mortem (Bull) fifty-two were described as normal, and fifty-two as altered. Of the fifty-two altered, in the great majority the description suggests what has been found in each case examined by the author, namely, the dilated oesophagus extends to the diaphragm, but the subdiaphragmatic portion is small and pencil-like, in

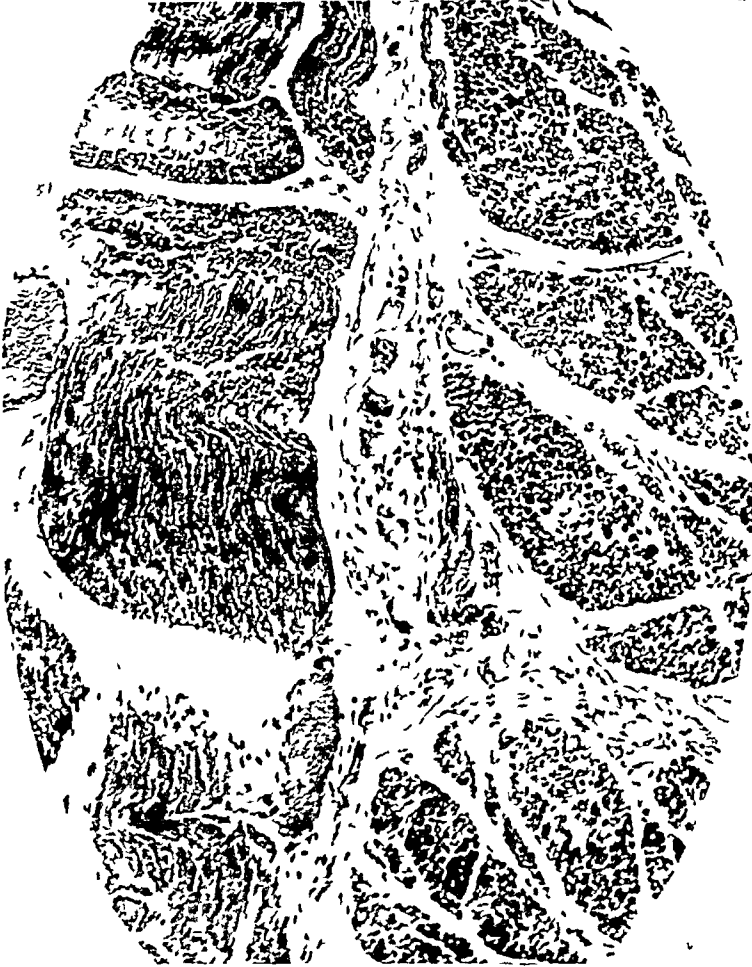


FIG 8—Microphotograph showing normal Auerbach plexus and contains four ganglia cells (Rake)

that sense contracted and the lumen narrowed, but with no hypertrophy or thickening of the muscular coat. In the dilated portion the muscular wall may be found as in Iwim Mooies' careful description of three cases either of normal thickness, thinner than normal or abnormally thick from hypertrophy of the muscular coat and inflammatory thickening of the mucous membrane. The lining mucosa may be smooth, but is often ulcerated and the submucosa thickened and infiltrated.

that a paretic muscle does not hypertrophy, but as Chizzola points out that does not dispose of the case

First there are the pseudo-hypertrophies associated with loss of power. There is the thickening of the wall apart from the muscular thickening, there is the analogy of the megacolon with hypertrophy and contraction but no advance of the contents and there is, above all, the fact that in the great majority of cases seen, no peristalsis can be seen under the fluoroscope so that while there may be contraction it may well have lost its coordinated sequence

There has been great difficulty also in interpreting the experimental evidence of the cardiac innervation. Many seemingly contradictory reports on the evidence of vagus and sympathetic stimulation are found, but the main trend of evidence points to the conclusion that there is both vagal and sym-



FIG 9—Microphotograph showing diseased plexus. Nerve fibres replacement fibrosis but no ganglion cells (Rake)



FIG 10—Microphotograph from Case II showing changes described by Rake

pathetic influence and that in general the action is comparable to that found elsewhere in the intestine and this in spite of the fact that peristalsis cannot be initiated by stimulation of one part of the œsophagus

There is anatomical ground for believing that atony of the longitudinal muscle must result in an inability to open the cardia and that there a break in the parasympathetic paths would result in a loss of tone in the œsophagus permitting dilatation and an inability to open the cardia in rhythm with the swallowing reflex

Ever recurring in the writings is the difference of opinion as between a primary spasm of the cardia and secondary dilatation of the œsophagus as believed by Miculicz, and an achalasia or failure to open as originally suggested by Meltzer. Against the principle of primary spasm of the circular muscle of the subdiaphragmatic portion of the œsophagus, it is always argued first that an obvious stenosis never results in a dilatation of anything like the degree usually found in idiopathic dilatation, second, that there is

diaphragm, the bringing down and therefore the straightening out of the elongated œsophagus without touching the muscle as in the Heller operation, or opening the lumen as when an anastomosis is done. The procedure is easily done and should be safe.

The idea of enlarging the opening in the diaphragm has been proposed before, first so far as I know, by Anthony Bassler in 1914 under the influence of Chevalier Jackson's contention that the closure of the cardia is brought about by muscular bands derived from the diaphragm. The procedure carried out in the three cases reported is as follows.

An incision as described by Marwedel in 1910, was made in the left paramedial line beginning about 2 inches above the xiphoid. The muscles are cleared from the cartilages of the seventh, eighth, and ninth ribs and pushed laterally. The cartilage of the seventh rib is cut through at the junction with the sternum, care being taken not to enter the pleura or pericardium. The cartilages of the seventh, eighth, and ninth ribs are cut through at the costochondral junction. In this way a flap consisting of rib cartilages and diaphragm can be retracted laterally exposing the left lobe of the liver. The coronary ligament of the liver is then cut as far as may be necessary to turn the left lobe of the liver down and to the right. This brings one to the fundus of the stomach and the subdiaphragmatic portion of the œsophagus. Loose areolar tissue is cleared away, a large vein crossing the crura ligated and cut. The opening through the diaphragm enlarged by cutting the crura. The fingers are then inserted through this opening and the œsophagus, which lies well over towards the right, freed from surrounding areolar tissue and brought down through the opening for 2 inches or more. In order to do this the right vagus nerve may have to be cut, but since the vagi form a plexus about the lower œsophagus this may be done without danger.

The edges of the enlarged hiatus are then sutured to the thickened muscular wall of the dilated portion of the œsophagus and the wound closed. This procedure has been followed in three cases as the appended case reports will show.

Subsequent examination under the fluoroscope shows that fluid enters the œsophagus as before, fills to a varying point 4 to 6 inches above the diaphragm and then begins to trickle through the narrowed cardia into the stomach.

It is necessary only that food should be finely divided and well mixed with fluid. After a meal it is advisable to take a quantity of water to prevent remnants of food remaining in the lower œsophagus.

#### CASE REPORTS

CASE I—Miss J P, aged forty-five. Complains of difficulty in swallowing. Onset sudden nine months previous to admission, with vomiting all food. Sensation of food sticking under the sternum with choking sensation. This has continued ever since. Relieved by regurgitation of food. Has gradually got worse. Feels hungry all the time and has lost weight.

sutured to the edge of the enlarged hiatus. It was fully two inches in diameter at this point. The abdomen was closed without drainage.

From the time of the operation till the present, she has been able to swallow food normally, provided it is finely divided and well mixed with water. She has regained her weight and strength.

X-ray plates (Fig 5) show the fluoroscopic picture nearly four and one-half years after operation.

The œsophagus has regained a nearly normal size, but still requires a 6-inch head of fluid column before food enters stomach.

**CASE III**—Mrs B McD, aged fifty-eight years, May, 1926. Difficulty in swallowing began about one year ago, more with solids than liquids. Takes food till she feels full up. Then by forceful efforts works the food down. Sometimes during these efforts she regurgitates. She then rests, fills the œsophagus again and again forces it onward. The œsophagoscope reveals a dilated thoracic œsophagus and a closed cardia which was found to grip around a bougie.

Since 1926 she has had more and more difficulty in swallowing, with regurgitation of food. In December, 1928, contracted influenza and was extremely ill, and could swallow no food. At this time tube feeding was instituted. She quickly learned to pass her own tube and has continued ever since. She has lost 80 pounds in the past three years.

*Operation* May 29, 1929. Œsophagoplasty. Marwedal's incision. The subdiaphragmatic portion of the œsophagus was found to be about 2 centimetres in diameter. The wall was not thickened. The opening in the diaphragm was enlarged, the dilated portion of the œsophagus brought down. At this point it was 2 inches in diameter and not notably thickened. In order to bring it down the right vagus was cut. Immediately following operation she was able to swallow normally and she has continued to be able to do so. No films available.

**CASE IV**—J S, aged fifty-eight.

*History of the present illness*—About one year previous to the operation he began to suffer difficulty in swallowing and what he took to be vomiting.

The onset was sudden but the course intermittent. Gradually the difficulty in swallowing became more severe and he regurgitated quantities of food mixed with mucus.

*Personal history*—The patient has been known to be diabetic for five years. The diabetes in moderate degree requires to take insulin. He used alcohol to excess. The Wassermann was negative.

*Operation*—Marwedel's incision. The subdiaphragmatic portion of the œsophagus was found to be about three-quarter inch in diameter. The hiatus was enlarged, the œsophagus freed and brought down 2 inches below the diaphragm. At this level the dilated portion was about 2 inches in diameter, the wall definitely thickened. The right vagus nerve and a branch of it were cut to allow the œsophagus to be brought through. Sutured to the edges of the opening.

Following this he swallowed liquid food freely. X-ray before leaving hospital shows the œsophagus as before, but when the head of fluid reaches about half way up the chest fluid begins to enter the stomach.

He returned home and was well until he had a violent attack of vomiting lasting three days. Reentered the hospital.

He vomited large quantities of coffee ground vomitus when taking no fluid by mouth. Stomach washing demonstrated that the vomitus was from the stomach and that fluid entered the stomach.

His blood sugar rare and he showed acetone in urine. Under the control of the diabetes and stomach washing the vomiting gradually ceased and he began to take food again. X-ray plates 3 and 4 demonstrate the condition of the œsophagus still dilated.

# THE PYLORIC SPHINCTER AND DUODENAL ULCER

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CHRONIC duodenal ulcer continues to occur without explanation or apology, and when we try to investigate its associated phenomena we find new wonders. The incidence of ulcer is increasing and we know of no preventive measures. All is not serene among those who treat the disease. It may get well without any treatment, but of this we have grave doubt particularly as it applies to chronic ulceration. Medical treatment undoubtedly can control symptoms but in our experience recurrence follows remission of treatment in the same fashion it does in the natural course of the disease with the exception that the period of absent symptoms is longer. Once established there seems to be an inherent tendency to duodenal ulceration or to the underlying disturbance of which it is a sequel, so that, for a time, it may be held in abeyance, but reactivity of the lesion is resumed when the methods of control are withdrawn. The results of surgical treatment in competent hands have been highly satisfactory. The selection of patients for operation plays a large part in beneficial results. Gastro-enterostomy for chronic duodenal ulcer especially in the presence of obstruction is one of the most satisfactory operations in surgery. Improved diagnostic methods, especially the X-ray and the widespread familiarity with the symptoms of ulcer have led to earlier recognition. Today, duodenal ulcer is operated on earlier by many surgeons and before the proverbial nine medical cures. The results in these early cases from gastro-enterostomy are not so highly satisfactory and the immediate good results seem to diminish as the post-operative period lengthens. The reason for this we do not know. Its investigation may uncover important therapeutic facts. We suspect that in these early operated ulcers with unsatisfactory results the state of pathologic physiology of which ulcer is a sequel is a temporary affair, which, when it spontaneously rights itself leaves the patient with an unnecessary gastro-enterostomy. The latter then may give rise to digestive derangements and symptoms and actually may favor the development of a marginal ulcer. Medical treatment has its value. When properly and faithfully followed, it may, in many cases, control the condition until the tendency to ulceration disappears. The difficulties as we see them are that by no method can one select and eliminate the candidates for chronic duodenal ulcer and any process of selection by medical treatment must face the dire hazards of perforation and hæmorrhage. We cannot see the wisdom of partial gastrectomy for duodenal ulcer. We admit that the indiscriminate use of gastro-enterostomy for every case of duodenal ulcer produces results which leave the surgeon in a position difficult to defend. Gastro-enterostomy occupies a conservative surgical position. Within the last four

investigators have confirmed the finding of Boldyreff that duodenal regurgitation occurs so commonly that it may be called a natural phenomenon

Thus, it would seem that the normal stomach under normal control produces a quantity of acid which is accurately regulated in keeping with digestive requirements and when, as the result of overacting stimuli, an excess of acid is formed the control mechanism of duodenal regurgitation provides the factor of safety

Quincke in 1889 observed a child with a gastrostomy and noted that during fasting the pylorus often remained open for ten minutes during which time bile and other intestinal fluids passed to and from the stomach. This so-called duodenal regurgitation was later studied by Boldyreff who concluded that it was a natural phenomenon and ascribed to it a regulatory rôle in the control of gastric acidity. The observation of Boldyreff has been widely confirmed and generally accepted but his theory as to the natural control of gastric acidity has been questioned by the results of recent experiments. The latter hold to the view that the normal stomach has an inherent ability to control its own acidity. But the stomach of an individual with duodenal ulcer does not exhibit normal function and there is a notable failure to control acidity. If what Pavlov states is true regarding the secretory behavior of the stomach, then the state of hyperacidity must result from an overproduction of acid, that is, beyond or independent of digestive requirements combined with failure of some mechanism whose purpose is the control by neutralization of excess acid. A number of investigators have made experiments on duodenal regurgitation in dogs by introducing into the stomach 200 cubic centimetres of 0.5 per cent hydrochloric acid. They found that the regurgitation of duodenal fluid into the stomach is a constant occurrence and that the rate of neutralization of gastric acidity can be accurately measured. That antiperistalsis in the duodenum is the force behind regurgitation is indicated by the X-ray studies of Salmond. In 100 consecutive human cases he observed antiperistalsis in the duodenum in ninety-three. The actual regurgitation through the pylorus into the stomach he has been able to see in some twenty odd cases but this, he states, is difficult to detect. Intragastric pressure is normally below 10 centimetres of water while duodenal pressure is between 10 and 15 centimetres of water. In their clinical studies, Wright and Medes found that regurgitation of duodenal contents into the fasting stomach occurred in 100 per cent of the cases and that it took place with special frequency as the stomach is emptied. The purpose of regurgitation obviously is to neutralize excess acid and in the process the pancreatic juice is the main factor. Hepatic bile is neutral in reaction and usually acid before reaching the intestines.

The division between stomach and duodenum is sharply defined anatomically and physiologically by the pyloric sphincter. Formerly it was thought that this muscular ring had much to do with the emptying of the stomach but in this it actually plays a small part unless by dysfunction or fibrous contraction a functional or mechanical obstruction exists.

Therefore, it would seem that the main efferent paths are in the splanchnic nerves. They found that epinephrin (whose specific action is only on structures supplied by true sympathetic nerves) induces contraction of the pylorus. They conclude that the predominant reflexes from the viscera into these sphincters (cardiac and pyloric) under their experimental conditions, is motor, and if prolonged they became cardiospasm and pylorospasm.

From a study of the work of the above investigators we believe there is evidence to indicate that the constrictor fibres of the pyloric sphincter are supplied by the sympathetic and the dilator fibres by the vagal nerves. It also seems well established that regurgitation of duodenal contents into the stomach is a natural phenomenon whose purpose it is to neutralize gastric acidity when the latter for any reason is produced in excess of digestive requirements. The pyloric sphincter by its strategic position presides over and controls the mechanism of duodenal regurgitation.

Hyperacidity by which we mean a real excess of hydrochloric acid can arise only from an overactivity of the stimulus which produces normal acidity. The main pathways for this stimulus are the vagus nerves since section of these nerves produces a permanent reduction in gastric acidity. Temporary hyperacidity probably is of frequent occurrence and its control is by the safety mechanism of duodenal regurgitation. One of the characteristics associated with duodenal ulcer is persistent uncontrolled hyperacidity. By means of the acid-test meal, patients with duodenal ulcer have been shown to have inadequate or absent duodenal regurgitation. For this the fault seems to lie with the pyloric sphincter which through failure to open (achalasia) or because of spasm acts as a hindrance to the needed reflux of duodenal contents into the stomach. Is this disturbance of function secondary to and caused by the presence of duodenal ulcer? According to the views expressed by Hurst, the answer is in the affirmative. He also explains the symptomatology of ulcer on the basis of dysfunction of the pyloric sphincter. We are in agreement with the latter view but on the basis of our clinical experience and the researches of others we hold that the symptoms precede the appearance of ulcer and that such symptoms are the expressions of a disturbed physiology of which ulcer is a sequel. Every surgeon many times has had the experience of operating on a patient who exhibited the characteristic symptoms of ulcer but no ulcer by a most thorough search could be demonstrated. Such instances particularly occur when the history of ulcer has been one of short duration. These symptomatic ulcers are often cured by medical measures. Little wonder that Moynihan was led to remark "The ulcer that cannot be demonstrated to the entire conviction of the onlooker does not exist." To the detriment of surgery we must admit that symptomatic ulcer has often been treated by gastroenterostomy. In these cases we have many times found the lesion in the appendix.

Most of the older work on the experimental production of peptic ulcer can be discarded. In our opinion the experiments of Mann by which he regularly produced typical peptic ulcers in dogs by his method of surgical duodenal drain-

duodenum When a gastroenterostomy is made following the appearance of the ulcer after Mann's surgical duodenal drainage the original ulcer promptly heals but a new ulcer usually develops in the jejunum opposite the anastomosis In patients with duodenal ulcer treated by gastroenterostomy and in whom symptoms were relieved Elman showed by means of the acid test meal that there was prompt and efficient neutralization of the acid

It is our belief that in the development of duodenal ulcer two etiologic factors are at work, neither of which can cause the ulcer without the cooperation of the other One is hyperacidity by which we mean an overproduction of acid The other is spasm or achalasia of the pyloric sphincter Hyperacidity no doubt occurs periodically in many individuals who never develop duodenal ulcer for the reason that they have an efficient safety mechanism in duodenal regurgitation Likewise pylorospasm must be of frequent occurrence in many individuals particularly in those who harbor an intra-abdominal focus of infection In these we often find the symptoms without the ulcer But when there occurs the combination of the two factors, that is, hyperacidity and pylorospasm, the offspring of this mating is ulcer We do not know the cause of hyperacidity The stimulus which produces it comes down the vagus nerves It is an exaggeration of the appetite or psychic phase of gastric secretion Less do we know of means to control it Perhaps complete mental and physical rest is the answer Indeed, patients with duodenal ulcer often experience complete symptomatic relief when they are able to obtain physiologic rest It is an important part of the medical treatment of ulcer But life must go on and such treatment cannot be followed indefinitely We know that pylorospasm is often a reflex from an intra-abdominal irritation In this way chronic appendicitis or cholecystitis, the two most common foci of infection within the abdomen, may under proper conditions play a large part in the etiology of ulcer Pylorospasm may also occur as a part of a general nervous disturbance which particularly affects structures supplied by sympathetic nerves and is manifested by sympathetic overactivity The work of Crile along this line deserves serious consideration He has advocated and practiced resection of the suprarenal glands for the cure of duodenal ulcer Many observers have noted that duodenal ulcer usually selects for its host an individual of a characteristic constitutional type

The active treatment of duodenal ulcer when carried out along rational lines especially with regard to etiologic factors to be successful, must attain one important result namely, the control of hyperacidity In what better way can this be done than by restoration of the natural mechanism for neutralization? This may be accomplished in an indirect manner by gastroenterostomy The results of this operation are not uniformly satisfactory when based on the experience of many surgeons Careful selection of patients will improve the surgical results but what is to be done for those patients who fail to qualify for operation? Must they serve an apprenticeship under medical treatment before being admitted to the operating room?

Many surgeons hesitate to recommend operation when the history of



remove completely all the muscle fibres in the anterior half of the sphincter. These errors have an effect on the post-operative results.

During the years 1928, 1929, and 1930, ninety-one patients with duodenal ulcer were operated on. Forty-four of these were treated by removal of the anterior half of the pyloric sphincter. In addition to the operation for ulcer, in many cases coincident lesions as appendicitis and cholecystitis received operative attention. This report concerns the forty-four patients who had a demonstrable duodenal ulcer and in whom the anterior half of the pyloric sphincter was removed. Four patients died in the hospital, one from respiratory failure three days after operation, one from uræmia ten days after operation, one from cardiac disease thirteen days after operation and one from peritonitis thirteen days after operation. Of the remaining forty patients, thirty-five were seen and examined at regular intervals in the follow-up service of the Lankenau Hospital over a period varying from two months to three and one-half years after operation. The examinations were made by members of the hospital staff. Results of the examination were graded from one to four. A patient who had complete relief of pre-operative symptoms was graded four while one who experienced little or no relief was graded one. On this basis, twenty-six patients were graded four, five were graded three and four graded two. It was noted that the improvement or relief of symptoms did not diminish as the post-operative period lengthened.

Fluoroscopic examination of the stomach after an opaque meal was made in sixteen patients during the course of the observations in the follow-up service. In all patients it was noted that the emptying time was normal or slightly accelerated although in many of these the pre-operative study had shown delayed emptying or actual retention. It was difficult for the roentgenologist to give a definite opinion regarding direct signs of ulcer in the duodenal cap because of the confusion arising from the proximity of the operative site. In all patients except three the indirect signs of ulcer had disappeared. Post-operative gastric analysis by means of the fractional test was carried out in a sufficient number of patients to determine that there was no significant change from the pre-operative findings. We do not attach much importance to these results for the reason that the usual fractional analysis after a test meal gives little positive information regarding duodenal regurgitation and the actual concentration of acid entering the duodenum. Important evidence regarding the efficacy of the operation on the sphincter in restoring duodenal regurgitation could be obtained by means of the acid test meal. This we have not done but propose to do it in future cases. At the present stage we can only say that regardless of laboratory studies the operation has given symptomatic relief.

*Conclusions*—It seems that duodenal ulcer usually occurs in individuals who have a constitutional hyperacidity. From experimental and clinical studies it seems that acid is the direct causative factor in the initiation and maintenance of duodenal ulcer. That all individuals with temporary or persistent hyperacidity do not develop ulcer is probably due to the safety control mechanism

# HÆMANGIOMA OF SIGMOID AND COLON

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HÆMANGIOMA of the large bowel is a relatively rare disease. Nevertheless the mortality has been so high and the operative results so unsatisfactory that the report of a case with a satisfactory cure seems justified. In the case to be reported the area of the tumor corresponded to the distribution of the superior hæmorrhoidal vein. Assuming that there would be a free venous communication between the vein and the dilated areas of the tumor, a plan was devised for obliterating the venous sinuses—with resultant cure. The details of the operative procedure, colostomy and later closure of the colostomy are described in the case report in the latter part of this article.

A search of the literature for hæmangiomas of the colon show few reported cases.

The end-results of these cases showed that death occurred from hæmorrhage, or resection or permanent colostomy were performed to relieve the symptomatology. As the disease is usually congenital, the symptoms of bleeding occur in early life, and as a result the normal activities of youth are restricted and the outcome is indeed tragic.

*Pathology*—If one accepts the theories propounded by Virchow, Ribbert, and Fraser that hæmangiomas are localized encapsulated tumors it is questionable whether one can definitely classify the vascular tumors seen in the large bowel under the terminology of hæmangioma.

Ribbert, working on cavernous angiomas with particular reference to the small telangiectatic tumors of the skin and the cavernomas seen in the liver, states that the tumor, consisting of vessels with thin walls surrounded by a connective tissue stroma containing few cells, has no direct connection with the capillaries of the normal surrounding tissue. There is no interconnection with the surrounding vessels, no indication that the dilated lumina gradually contract to merge with the capillaries or possibly have developed from them. This impression, according to Ribbert, is absolutely not changed by the fact that arterial vessels enter while venous vessels emerge from angioma or that individual sections demonstrate this communication. Ribbert also says that there is no justification for assuming that originally the vessels of the hæmangioma were the normal part of the vascular system and developed later into a tumor. He believes that the vascular complex producing the new growth was an independent entity from the beginning and not a preexisting dilatation of normal vascular channels. Virchow, Rindfleisch, and Ribbert believe that cavernomas are due to the primary development of connective tissue infiltrating the surrounding tissues gradually without any distinct mi-

extent infiltration occurs in muscle, the tumor extending between individual muscle fibres. Where nerves are present the sheath of the nerve is invaded, and there is a spread inwards between individual nerve fibres.

3—*The Development of the Cavernous Type of Hæmangioma*—If the embryonic capillary tissue develops a connection with the circulation, the cavernous type of hæmangioma may result. The original embryonic capillary vessels become distended, probably from the passage through them of the circulating blood under some degree of pressure. The lining endothelium becomes very much thinner, and the cavity is filled with blood, which, judging from the character of its corpuscular elements, is in active circulation. In this last respect the contents of the cavernous hæmangioma differs very markedly from that of the capillary type, the corpuscular contents of which are either imperfectly developed or degenerated. It is the exception to find a tumor in which the cavernous change has become general, in almost every instance, if the cavernous tumor is present, it is associated with the capillary type, and with varying changes in transition between the two.

4—*The Development of the Compact Type of Hæmangioma*—If, for some reason, the endothelial cells lining the capillary type of tumor take on active proliferation, the compact type of hæmangioma may develop. Generally the proliferation is perivascular in type, occasionally it is endovascular, the cells projecting in papilla-like arrangement, and becoming arranged in concentric masses and whorls. The development of the compact variety of hæmangioma is accompanied by a localization of the tumor.

In our case, where no specimen was removed for examination, it is difficult to state whether or not the diffuse cavernous dilatation of the vessels was in truth a tumor growth or a dilatation of existing vessels. As can be seen in the illustration there was no sharp demarcating line between the angioma and the normal bowel. Throughout the area of about an inch and a half there was a gradual transition from dilated to normal vessels. Also it was obvious that there was a free, open communication between the superior hæmorrhoidal vein and the dilated vessels within the lumen and on the surface of the affected colon.

*Symptoms*—As can be seen in Chart I the most prominent symptom in the cases reported is repeated bleeding from the rectum, often beginning in infancy. As a result, a true anæmia occurs, frequently associated with asthenia and cachexia. The hæmorrhages may be small, or sufficiently massive to cause exodus. In a number of cases hæmorrhoidectomy has been performed without satisfactory cure. In one case intestinal obstruction was created by a pedunculated submucous angioma.

#### SUMMARY OF REPORTED CASES

CASE I—Reported by Barker, 1883, male, forty-five years of age. Symptoms—Diarrhœa with hæmorrhage, occasional constipation. Duration—"Since boyhood." Treatment—Injections of Tr. Fer. Perchlor. Rest in bed. Results—Death. Nævroid growth in lower rectum.

be suspected If the angioma occupies the rectosigmoid, the diagnosis may be readily made from the appearance as seen by proctoscopic examination Unless there should happen to be a pedunculated tumor X-ray is of little importance from a diagnostic point of view

**CASE REPORT**—B L, male, Russian Jew, born in the United States, aged seventeen First admission to Fifth Avenue Hospital March 12, 1930 *Chief complaint*—Bleeding from rectum Since fifteen months of age patient has complained of frequent attacks of bleeding from the rectum He has had no pain except when passing a constipated stool Has periods of diarrhoea and constipation, and stools always appear streaked with very dark blood At times when he has diarrhoea he passes bright red blood, which varies in amount from a quarter to a half glass at a time There are times when he uses mineral oil, when he has very little bleeding These times he may bleed only once out of about ten times

*Past History*—Diphtheria as a child At four years of age had an operation for hemorrhoids, and other rectal operation, of which he is not quite certain, at about six years of age Becomes short of breath on exertion, and has had fainting sensations and has fainted occasionally after any muscular exercise His best weight has been 142 pounds, at present he weighs 130 Has never been able to exercise on account of faintness

*Physical Examination*—Pale, slender youth Eyes react to light and accommodation Pupils are equal Mouth in good condition Tonsils absent Lungs clear throughout Heart Regular rhythm, fair quality Has a powerful beat with P M I within mid-clavicular line in fifth interspace No irregularity or murmurs Abdomen negative Some gas in intestines noted

*Digital Examination*—There is no enlargement of the prostate, or noticeable hemorrhoids There seem to be a few tabs of mucosa just within the sphincter

*Laboratory Examination*—*Urine*—Specific Gravity, 1020 Very faint trace of albumin Microscopic negative *Blood Count*—Hæmoglobin, 32 per cent, Red Blood Cells, 2,800,000, White Blood Cells, 6,500, Polynuclears, 77 per cent, Lymphocytes, 23, Achromia, Aniscytosis, Poikilocytosis *Blood Clotting Factors*—Prothrombin, 10, Fibrinogen, 0.64, Antithrombin, 10, Platelets, 370,000, Disintegration, 40 per cent, Index 0.6

*Proctoscopic Examination*, March 12, 1930—Sigmoidoscope admitted without meeting any obstruction for ten inches Examination reveals a red, beefy mucous membrane, with areas of blue cystic spaces beneath, and thin, smooth mucous membrane extending upward as far as can be seen through the sigmoidoscope and downward to the sphincter ani There are two small hemorrhoids just within the sphincter

*Diagnosis*—Congenital angioma of the rectum

A similar proctoscopic examination had been made two weeks before admission, and the patient referred to Dr Harvey Stone, in Baltimore, with a request for his opinion, without the author having stated his own diagnosis

Following is the report from Doctor Stone "The boy has two distinct lesions which may, or may not, be related to each other There is a fairly large and vascular internal hemorrhoid just to the left of the posterior commissure, and a smaller one further to the left of this In addition to that, the rectal mucous membrane from just above the valves to ten inches up (which was as far as I could see) presents a curious condition The veins are greatly dilated and engorged and tortuous They stand out like blood splotches against the pale mucous membrane I think this is a congenital angioma

*Comment*—A boy of seventeen years of age presented himself for treatment, having had repeated bleeding from his rectum since fifteen months of age He had a marked secondary anaemia and suffered from repeated bleed-

ligature placed about it and tied. A needle attached to a hypodermic syringe was inserted into the lumen of vein distal to ligature and 10 cubic centimetres of 40 per cent sodium salicylate injected, very little spilling. It appeared to the operator and his assistant that shortly after this the purplish color of the intestines became lighter—almost pink. Ves-



FIG 1.—Artist's sketch made at operation. Exposure of superior hæmorrhoidal vein through mesial sheath of meso sigmoid. Upper portion shows gradual transition of the tumor into normal bowel.

sels felt firm. The vein was again ligated below insertion of needle and the peritoneal cavity washed out with saline. The rent in the mesosigmoid was closed with chromic suture. A left McBurney incision was then made, incising skin and inserting Kelley clamp and spreading it so as not to split aponeurosis of oblique muscles any more than was necessary. Tape about the sigmoid was drawn up through this incision and the



FIG 2—Artist's sketch taken at operation. Injection of the superior hemorrhoidal vein with sclerosing solution.

- Helverstine, F, Jr Hæmangioma of the Intestine ANNALS OF SURGERY, vol lxxviii, pp 42-47, 1923 His own case in small intestine, but summarizes Tuffier's, Hartman's, and Dujarier's cases (qv)
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- Marsh, H (Case) Lancet, vol 1, p 637, 1883 Reported during discussion of Barker's case
- Reichel, P, and Staemmler, M Die Neubildungen des Darmes Stuttgart, Enke, 1924 (Neue deutsche Chir 33a) Hæmangioma, pp 282-284 Bibliography, p 372
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- Hume, Graydon O Hæmangioma of the Rectum Guy's Hospital Gazette, vol xxxvi, p 360, September 2, 1922
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- Virchow Pathologic Tumors, vol iii, p 394

in the hands, however. On palpation the hands felt cold and on measurement of the surface temperatures a very sharp vasoconstrictor gradient in the hands was evident. The palmar surface of the fingers registered a temperature of  $22^{\circ}$  when the room temperature was  $19.4^{\circ}$  C. The surface temperature at the wrist was  $28.5^{\circ}$  C and in the lower arm was  $29.5^{\circ}$  C. This patient had never had any symptoms aside from coldness of her hands which she herself had noted.

This is a much greater degree of vasoconstriction than most individuals will show in the fingers under ordinary conditions with a room temperature of  $19-20^{\circ}$  C. It is difficult to get evidence of spasmodic attacks in these people, many of whom give a story of cold hands and cold feet most of the time. It may be that this is a mild type of reaction which in its more severe forms presents the angiospastic attacks which we call Raynaud's disease. But it seems hardly legitimate to classify this as Raynaud's disease although the difference may be only in degree.

*Idiopathic Paroxysmal Arteriospasm (Raynaud's disease)*—There have been a number of patients with paroxysmal arterial spasms not due to some other disease or injury. Such attacks usually come on in cold weather, but sometimes also during the warmer parts of the year. These patients are completely relieved between attacks at which time upon examination they seem to have normal blood-vessels. The areas involved usually are symmetrical ones on the hands, the feet, or both. The degree of involvement ranges from a mild one with transient dead fingers or toes to a severe one in which attacks of ischæmia are frequent and prolonged, ultimately ending in gangrene of one or more digits. It is possible to bring on typical attacks by exposure of the extremities to a proper degree of coldness, or by allowing rapid evaporation of moisture from the exposed extremities. The attacks are often accentuated by reflex painful, or psychic stimuli, or may be started by such stimuli when the environmental conditions are suitable. The following three case histories bring out certain points which we wish to emphasize.

CASE II—E. D. J., Strong Memorial Hospital, No. 45225, a forty-six-year-old housewife, had been having attacks in which several fingers became white, cold and numb during the past eighteen months. The fingers involved remained cadaveric or deeply cyanotic for one-half hour or more at a time and then the circulation gradually returned to these areas accompanied by a tingling sensation. There was no pain during the attacks but the involved fingers were hypersensitive immediately afterwards, on two occasions there has been aching in the arm. Also the attacks were much more apt to occur in cold weather or when she got her hands in cold water, though the low temperature was by no means the only factor in initiating them. The patient had noted herself that the attacks were more numerous when she was nervous, and they frequently occurred upon awaking in the morning. There had been no trophic changes but she was not able to carry out as well-skilled movements with the fingers such as in the use of a needle unless she had warmed her hands in warm water first. Her feet suffered similar changes but the attacks here were less noticeable to her.

Pulsation in all major vessels in the extremities was good even during the attacks. A number of attacks were seen in the clinic involving especially the right index and middle fingers and the thumb. Such attacks were induced by immersion of the hands in cold water of the proper temperature. However, they were not uniformly reproduced.



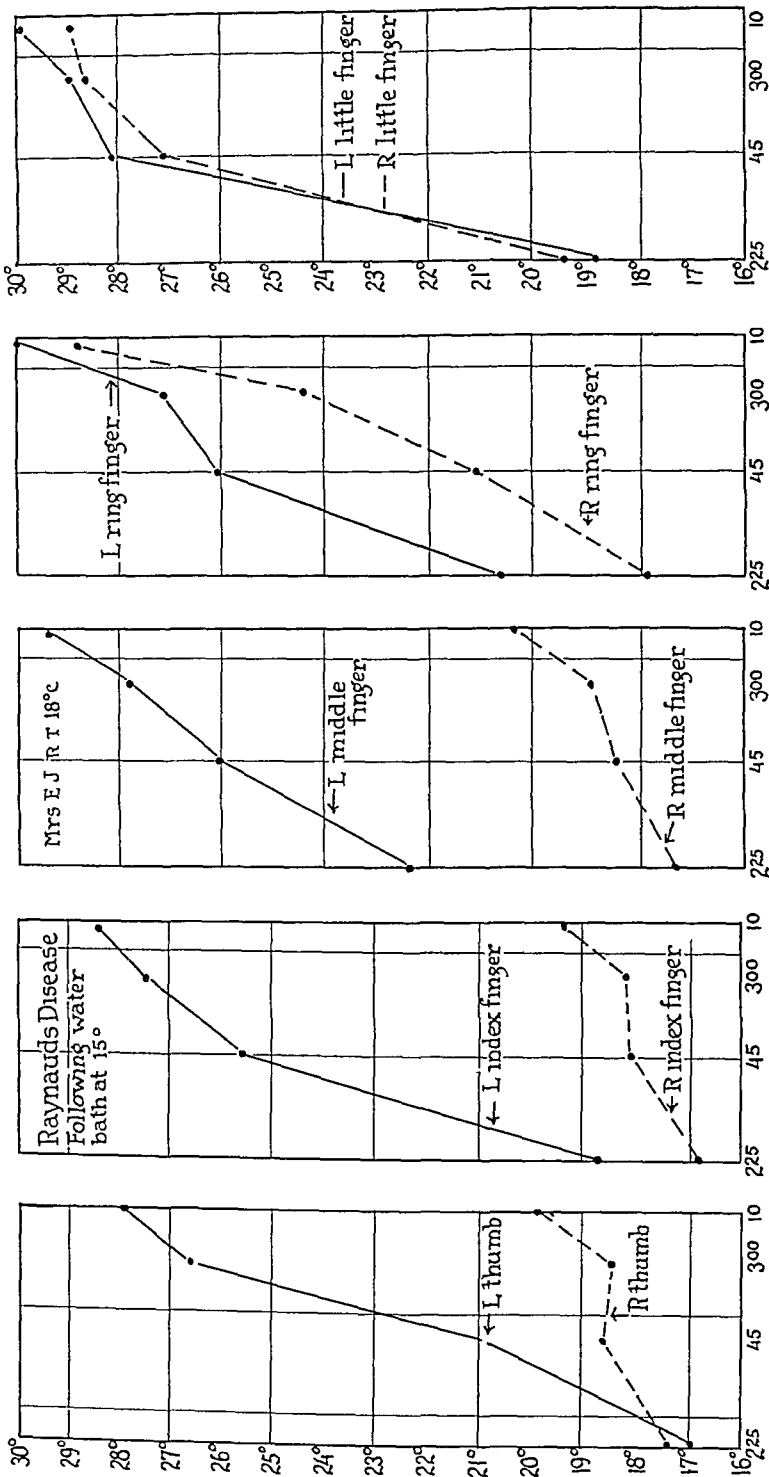


FIG. 2.—Case II. Raynaud's disease. Surface temperature of the fingers after immersion for ten minutes in water bath at 15° C. Note that the right thumb, index and middle fingers, which were the ones chiefly involved in this case, recovered their temperatures very much more slowly than the corresponding ones on the left hand and the ring and little fingers on both hands.

frequent when she was nervous. Objectively, we were able to bring on clear-cut mild attacks of ischemia by psychic, painful or reflex stimuli as described in the history.

CASE III—C H D, Strong Memorial Hospital, No 46368, a salesman, aged fifty-eight, came to the hospital on April 20, 1931, having had a variety of treatments for Raynaud's disease during the past nine years. The onset of symptoms was abrupt, noted first in the toes but soon appearing in the fingers. The attacks consisted of sudden painless pallor of the digits, followed by prickling, numbness, and aching, and by an intense cyanosis. Moderate cold (as cool tap water) would bring on an attack. Spontaneous recovery occurred after a varying interval of one-half to two hours. The attacks were much more frequent in cold weather but he was not entirely free from them during the summer. The involvement was symmetrical, and soon after the onset of the trouble the fingers became more severely affected than the toes. Five years ago he had had a small spot of dry gangrene on the tip of the right ring finger lasting three months. Three years ago, there was a recurrence of ulceration at this point which did not entirely heal for two years. During the past winter the attacks had become more severe and in the feet the area of pallor and intense cyanosis had extended back over the metatarsals instead of being limited to the phalanges.

A significant point in the history was that the attacks were very often brought on by some unexpected event. Thus if he had been sitting quietly reading for an hour or more in a room of moderate temperature and the telephone suddenly rang, an attack would frequently be initiated. His fingers would become cyanotic before he could reach the telephone. This important effect of psychic stimuli in bringing on attacks was clearly demonstrated several times while the patient was in the hospital. Thus, the first trip to the constant temperature room (no cooler than the temperature of the room from which he had come), the introduction of a hypodermic needle, or even the description of a perineural injection that was to be carried out initiated sharp arteriospastic attacks. On the morning that the patient was to be shown to the students on rounds, his hands were exposed on the porch for an hour in order to bring out the typical appearance. In spite of the fact that it was a cool morning when we came to see him after this period of exposure the hands showed only a slight cyanotic tint, in fact as a demonstration of an attack of Raynaud's disease their appearance was at this point a complete failure. As soon as the group assembled about his bed the color of the hands immediately began to change and they became profoundly cyanotic within three minutes. The different attacks observed during his stay in the hospital varied in severity and duration. In them the whole hand became cyanotic but the fingers were most intensely so, the distal two-thirds being a bluish black in the more severe attacks. In a typical one of the latter, the right ulnar nerve was blocked with novocaine, anesthesia being complete within ten minutes. By the time sensation in the ulnar areas was lost, blotches of red had appeared in the anesthetic area of the palm and at the base of the little finger. During the next fifteen minutes these spread to include the whole of the ulnar area in the palm, the proximal and part of the middle phalanx of the little finger, and areas on the ulnar side of the proximal phalanx of the ring finger (Fig 4). The rest of the hand as well as the other hand remained cyanotic. The terminal phalanx of the little finger became lighter in tint but did not lose its cyanosis. The temperature on this finger rose a maximum of  $2^{\circ}\text{C}$  as compared with an increase of  $5^{\circ}\text{C}$  in the anesthetized area of the palm. The color of the distal half of the ring finger did not change from its profound cyanosis and no difference in the tint of its ulnar and radial sides was discernible although the former was anesthetic and the latter was not. There was no increase in the surface temperature of the distal phalanx of this finger. The next day the right posterior tibial nerve was anesthetized by perineural infiltration just below the internal malleolus. The cyanosis in the hands which was only moderate before the injection was intensified for several minutes immediately after this procedure. The patient had been under observation in the constant temperature

room for an hour previously and the soles of the feet were cold and markedly cyanotic. Anaesthesia was evident on the plantar surfaces of the foot and toes in twelve minutes. About five minutes later redness appeared on the heel and sole of the foot and slowly progressed over the metatarsal heads and onto the toes. The tips of the first, second and third toes remained blue for twenty minutes after anaesthesia was established, but the cyanosis here finally disappeared and the whole anaesthetic area became a bright pink in sharp contrast to the violet color which persisted unchanged on the sole of the other foot (Fig 5). The temperature in the anesthetized toes rose more slowly than normally but increased  $9^{\circ}\text{C}$  and came to within one degree of the normal vasodilatation level.

This case likewise would be questioned as Raynaud's disease by some physicians because of his age and sex. There was nothing to make one



FIG 5.—Case III. Raynaud's disease. Effect of blocking the right posterior tibial nerve. (A) Before injection. (B) Half an hour after injection cyanosis has been displaced by hyperæmia everywhere except the second and third toes and the tip of the first toe. (C) Ten minutes later the cyanosis has disappeared from these residual areas. The cyanosis in the left foot (like that of A) remained unchanged throughout.

suspect thrombo-angitis and in every regard the ischæmic attacks were characteristic. Here, again, the patient volunteered information that any unexpected event was likely to start an attack in his hands, and we were able objectively to cause obvious arterial spasm in the hands by psychic and by painful stimuli.

CASE IV—F C B, Strong Memorial Hospital, No 38360, a thirty-two-year-old clerk, came to the clinic in September, 1930. Since the age of twelve he has had attacks of extreme cyanosis in the hands and feet, brought on principally by exposure to cold. Ten years ago the second toe of the left foot became sore and ulcerated and for four years it was impossible to heal this lesion. Six years ago a left periarterial sympathectomy

was done and when this did not improve the condition of the toe, the latter was amputated. The wound healed without complication. The lateral side of the left foot had ulcerated on several occasions but had always healed slowly. The hands also were subject to attacks of cyanosis but had not shown any trophic disturbance. The patient had to protect his hands and feet in cold weather. Following a very severe attack he had some pain.

The patient was obese, with scanty hair and a feminine habitus. His appearance suggested hypopituitarism though the X-ray of the sella was normal. We have seen the patient in several attacks during which the feet became extremely cyanotic and the hands markedly so. During the attack good pulsations in the major vessels of the extremities were palpable. An attack was brought on by exposure in a cold room. After the fingers had become deeply cyanotic and the soles of the feet an intense blue, the left posterior



FIG 7—Case IV. Raynaud's disease. Effect of blocking the left posterior tibial nerve. This figure illustrates the stages in the recovery of the left foot shown in Fig 6. (A) Ten minutes after injection of nerve. Areas of red appearing in the sole of the foot and the great toe. (B) About twenty minutes after nerve injection cyanosis had disappeared completely from the whole sole of the foot and toes except the end of the third toe. This still was deeply cyanotic. (C) Thirty minutes after nerve injection the cyanosis on the third toe had also completely disappeared.

tibial nerve was blocked by the injection of novocaine about it. In five minutes areas of bright red sharply contrasting with the deeply cyanotic background appeared on the sole of the foot and soon afterwards also in the middle of the plantar surface of the great toe. These islands of red color spread gradually until the whole plantar surface of the foot except the third toe was a bright red. About twenty minutes after the induction of the anesthesia, this digit also slowly became as bright red as the rest of the foot (Figs 6 and 7). The sole and heel of the right foot (uninjected) remained cyanotic throughout to the end of the two-hour observation period. Spontaneous recovery had occurred in a few areas on the toes, particularly the fourth toe which had become a fairly bright pink. The surface temperatures in the anesthetic area came up to the normal vasodilatation level while the temperature of the toes on the unanesthetized side remained between  $21.5^{\circ}\text{C}$  and  $23^{\circ}\text{C}$ , room temperature being  $20^{\circ}\text{C}$  (Fig 8). This vasomotor

nerve Recovery of color from the pallid or cyanotic to the pink phase takes place in the same patchy, slowly advancing way as it does when there is spontaneous recovery from an attack The surface temperatures may slowly mount to the normal vasodilatation level, or the level may not be reached in certain severe cases

It seems certain from these studies that the essential abnormality in Raynaud's disease is a local hypersensitiveness of the peripheral smaller arteries to cold as Lewis has emphasized There is no sudden release of spasm as one would expect on paralyzing the central vasoconstrictor mechanism by conduction block anæsthesia It may be significant, however, that spasms provoked by cold usually occur only in the areas which normally exhibit a vasoconstrictor gradient From our observation we are inclined to stress the importance of the vasoconstrictor influence in this condition more than Lewis has in his writings The voluntary subjective histories of initiation or accenuation of attacks by nervous factors in these patients has been substantiated by objective tests in our hands in a sufficient number of instances to make us believe that the vasoconstrictor mechanism also has an important rôle, though perhaps usually a secondary one Thus our opinion is that Raynaud's disease is not primarily due to an abnormality in sympathetic innervation, yet that the majority of the attacks except in the most severe cases are initiated or accentuated by vasoconstrictor stimuli under the ordinary living conditions of these patients We have not seen a case of Raynaud's disease where regional anæsthesia failed to cause some improvement in the circulation to the ischæmic extremity, though in the more severe cases, the most distal part of the extremity might remain uninfluenced by it The more or less extensive relief afforded by surgical removal of vasoconstrictor influences also tends to bear out this opinion We feel, therefore, that there is a proper justification for radical surgical attack on the sympathetic system in severe cases provided that it can be shown by appropriate tests that the surface temperature in the involved digits can be brought nearly to the normal vasodilatation level (This is also in agreement with Lewis's opinion though he does not give it much prominence) On the other hand, it is futile to operate on every case of Raynaud's disease with the expectation of a complete cure When the hypersensitiveness to cold is so pronounced that release of vasoconstriction by appropriate tests fails at ordinary room temperatures to raise significantly the surface temperatures in the digits, a poor result must be inevitable from any operative procedure We believe, then, that in typical Raynaud's disease there is a dual control operating to cause spasm of the peripheral vessels The essential defect is a hypersensitiveness of the peripheral vessels to cold But the vasoconstrictor influences are powerful in bringing on and keeping up attacks and their removal may be effective in prevention

*Angiospasm in Functional and Organic Nervous Disorders*—The functional and organic nervous system disorders may at various times exhibit derangements of the vasomotor mechanism to the extremities We have

The interesting feature in regard to this patient was that the surface temperatures in the left toes were constantly two degrees cooler than in the right. After blocking the left posterior tibial nerve, however, the temperature of the left foot came up to the normal vasodilatation level and there was no evidence suggesting organic disease of the blood-vessels (Fig 9). Evidently then, in this case of post-traumatic hysteria, there was an increased vasoconstrictor tonus in the involved foot. It would be of interest to know whether hysterical manifestations in an extremity are regularly accompanied by a similar increased vasoconstrictor activity or whether this was a fortuitous feature in this instance.

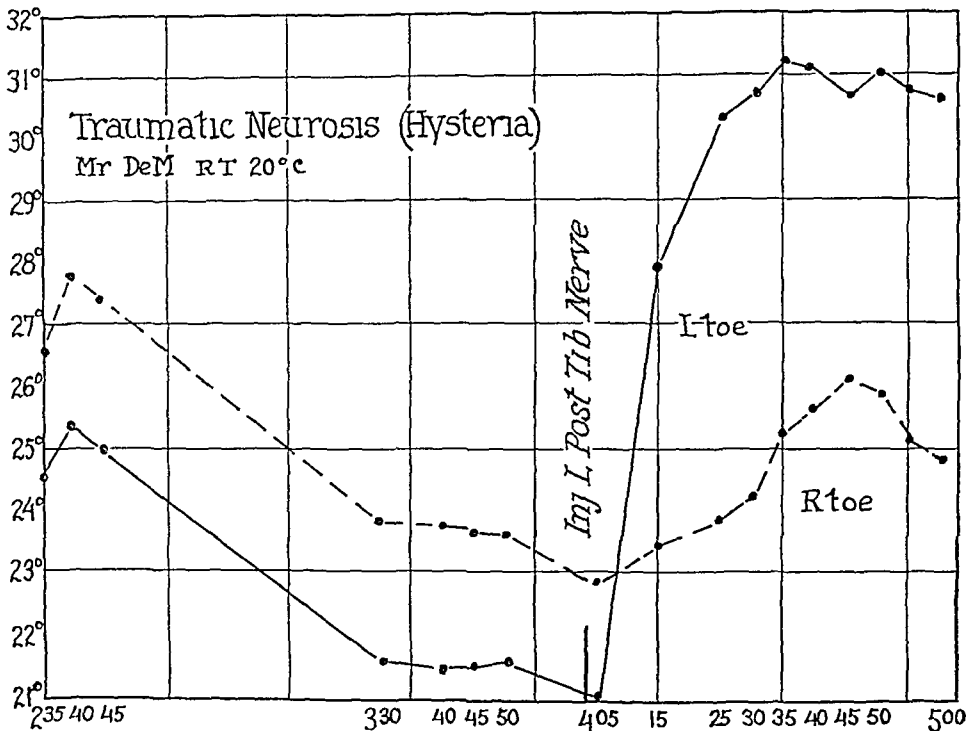


FIG 9—Case I I Traumatic hysteria. Surface temperatures on the toe of the affected side remained  $2^{\circ}\text{C}$  below that of the uninvolved side. After blocking the left posterior tibial nerve the temperature rises sharply above that of the normal foot and reaches the normal vasodilatation level.

CASE VII—M S, Strong Memorial Hospital, No 8919, a sixty-three-year-old housewife, with moderate general arteriosclerosis and occasional symptoms of cerebral arteriosclerosis, had a Colles fracture of the left wrist in April, 1930. Following this she had numbness and pain in the left thumb, the index and middle fingers. The pain increased and became burning in character. The application of cold to the peripheral area produced very intense pain, so that at home she constantly wore a woolen sock over this hand. This effect of cold was verified in the clinic by putting the patient's hand in water at  $13^{\circ}\text{C}$  for ten minutes which produced an intense pain and from which the involved fingers recovered their temperatures more slowly than the corresponding areas of the opposite hand. This was a typical causalgia of so severe a degree that alcohol injection was resorted to. The median nerve was blocked just above the wrist, it was found that this nerve had become adherent to the callus at the site of the fracture in the ulna. Anæsthesia has persisted and the patient has remained free of pain for six months since.

CASE IX—C A E, Strong Memorial Hospital, No 30176, a forty-three-year-old laborer, injured the index, middle and ring fingers of the right hand on October 16, 1929, by getting them caught between two heavy stones. There was considerable pain and nausea following the accident, but the skin was not broken and the patient kept on working. No particular symptoms were noted by the patient for four or five days at which time the injured fingers began to ache and became extremely sensitive on exposure to cold. Tactile stimuli in this area also became painful. After exposure to cold, the involved fingers became a deep blue. Two weeks after the accident he stopped work on account of the pain in these fingers. We saw him first on December 3, 1929, when he had come in out of the cold weather. The distal two phalanges of the ring and middle fingers on the right hand were a very deep blue and at first glance appeared gangrenous. The rest of the hand was of normal color. On putting his hand under the warm tap water the intense cyanosis disappeared completely and was replaced by a bright pink color. On another day in a warm room a difference of three degrees in

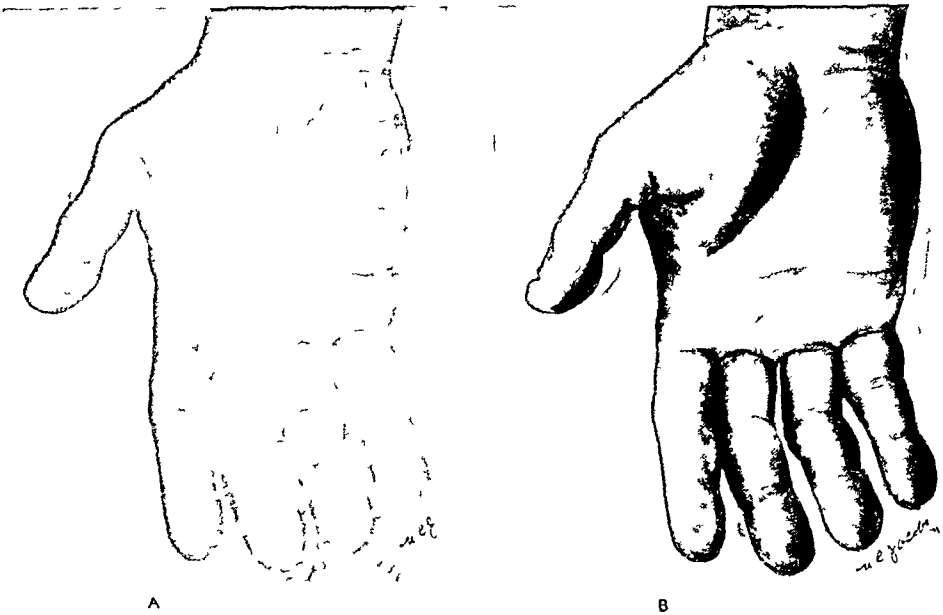


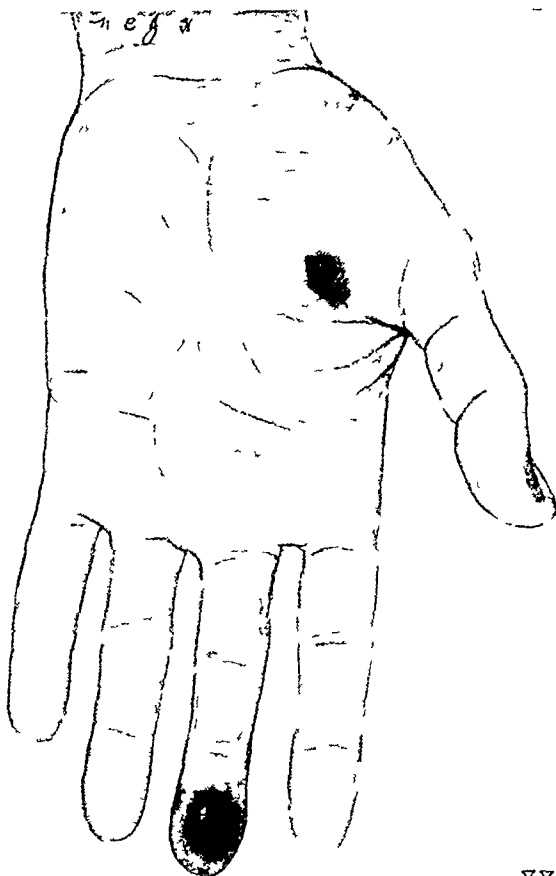
FIG 10—Case IX. Angiospasm post traumatic. (A) Fifteen months after trauma the effect of cold brings out ischemic areas on the ring and middle fingers of the right hand. (B) The angiospasm entirely subsides at ordinary room temperature ( $10^{\circ}\text{C}$ )

the temperatures of the index, middle and ring fingers from the corresponding ones on the left hand was measured, while the temperatures of the little fingers were within one degree of each other. In a cold room this difference in temperatures between the involved and uninvolved fingers became considerably more. Hot and cold contrast baths to the part and Bier's hyperæmia were prescribed. Under this treatment his fingers improved somewhat and with the coming of warmer weather in the spring ceased to bother him. The following winter, however, with the advent of cold weather, he had a recurrence of his trouble limited to the terminal phalanges of the right ring and middle fingers. In these areas the ischæmia brought on by cold became so intense that anæsthesia was produced, on one occasion to such a degree that, without realizing it, he burned the tip of his middle finger.

On January 30, 1931, fifteen months after the original contusion, he came into the hospital on a cool morning with an attack of intense pallor involving the terminal phalanges of the right index and middle fingers with a narrow band of marked cyanosis proximal to this (Fig 10). This area was  $6^{\circ}\text{C}$  colder than the corresponding area

of the opposite hand. At ordinary room temperature ( $19^{\circ}\text{C}$ ) however, this angiospasm rapidly subsided and the temperature in this area came up to the same level as on the opposite side. The patient was again exposed to cold bringing back the difference. The right median nerve was blocked and the temperature rose rapidly to the vasodilatation level in the middle fingers going  $4^{\circ}$  above the temperature of the corresponding finger on the uninvolved and uninjected side (Fig 11). The patient has been followed and, with the coming of warm weather again, is free from symptoms.

Some of the outstanding points to be noted in angiospasm following trauma are (a) The hypersensitivity to cold, (b) the long duration of the



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FIG 12—Case X. Venospasm. The principal lesion in the attack is on the left middle finger which is tense, congested and elevated above the surrounding level.

vascular spasm after the acute effects of the trauma have subsided and the injured tissues have been repaired by scar, and (c) the fact that this predisposition to angiospasm may pass into a latent stage and remain dormant for a long interval to be brought out again by certain conditions, particularly by cold. The frequency with which some degree of angiospasm follows many different types of trauma convinces us that an increased vasoconstrictor activity is a fundamental response to trauma and scar formation. We see this reaction definitely in causalgia when a nerve trunk is involved in the scar,



We have advised the patient to have the left median nerve blocked by novocaine in order to determine whether this would relieve the congestion and pain but she did not consent to this

Examples of true angiospasm on the venous side are certainly rarely recorded in the literature, and little is known about their cause and natural history. In this case it was our opinion and that also of the neurologic consultant that the venospasm was the expression of an underlying psychoneurosis. On the therapeutic side our endeavors were directed against the latter condition, but she did not stay under our care long enough to determine the final result.

#### CONCLUSIONS

(1) There are several types of angiospasm which can be recognized and separated into major groups as follows:

(a) In organic vascular disease, (b) idiopathic paroxysmal (Raynaud's disease), (c) dependent upon organic or functional nervous diseases, (d) consecutive to trauma, (e) venospasm.

(2) In Raynaud's disease the fundamental abnormality is a hypersensitivity of the peripheral arteries to cold. However, vasoconstrictor impulses play an important role by initiating and accentuating many of the attacks. Consequently, the advisability of removing the sympathetic innervation can be determined by the effect of regional anæsthesia in releasing the spasm during an attack.

(3) Organic and functional nervous disorders frequently are accompanied by an accentuated vasoconstrictor tone locally.

(4) Trauma in the extremities may be followed by an arterial spasm, frequently associated with pain. This is probably due to vasoconstrictor impulses induced by reflex afferent stimuli from the traumatized area. We

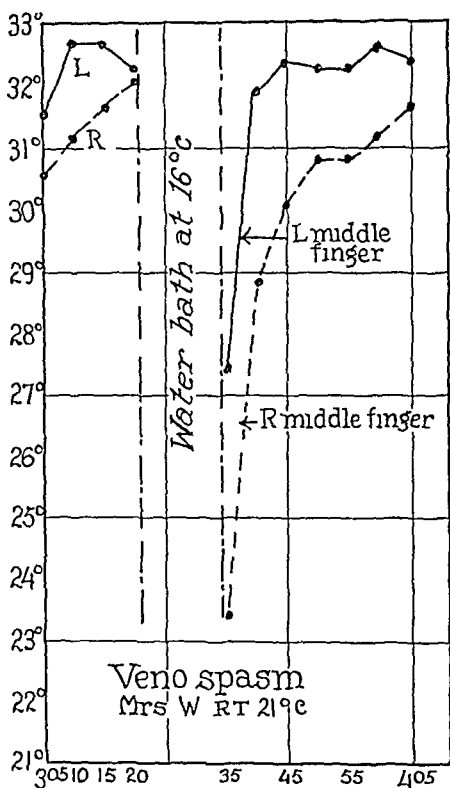


FIG. 13—Case 1. Venospasm. Surface temperatures on the middle fingers. Note that the involved side is at a higher temperature both initially and immediately after immersion in a cold water bath; also that it recovers its pre-immersion level much more quickly.

believe that such a reaction is a fundamental response incident to trauma and scar formation. There is an individual variation in the degree of manifestation of this reaction and it may be present as a latent hypersensitivity to cold.

(5) Evidence is presented that angiospasm affecting principally veins occurs as a clinical entity.

# THE DIAGNOSIS AND PRINCIPLES OF TREATMENT OF CARCINOMA OF THE COLON AND RECTUM

BY DANIEL FISKE JONES, M D

OF BOSTON, MASS

WE HAVE been discussing a subject which should command more attention than has been given to it by the medical profession in general, and this lack of attention starts in the medical schools many times. The importance of a disease should be determined by the value of treatment in prolonging life and in making it more comfortable for the patient rather than by the number of cases seen. If we compare the results of treatment in cancer of the colon and rectum in prolonging life and making it more comfortable with the results of treatment of other serious diseases, we must come to the conclusion, I believe, that it stands high on the list of important diseases. That the disease should stand high among important diseases is shown by the fact that although the diagnosis is made so late in the course of the disease (25 per cent to 50 per cent of those seen are operable), between 45 per cent and 50 per cent live in comfort for five or more years.

That carcinoma of the colon and rectum is not considered one of the important diseases is well illustrated by the Massachusetts statistics. There are, in Massachusetts, 11,000 deaths from carcinoma each year, and of these about 12 per cent are in the intestine, that is, about 1,200 cases of carcinoma of the colon and rectum die each year. After considering the work of various hospitals, it is difficult to believe that there are more than 150 radical operations, probably less, each year. It is evident, therefore, that about 10 per cent of the patients with this disease are given a chance for life and comfort. It is possible that 50 per cent of the patients in the state get either a radical or a palliative operation, many, therefore, are given no opportunity to be more comfortable and undoubtedly many get no consideration by a competent authority. It is probable that not more than 60 patients out of the 1,200 live five or more years.

The waste of life then is very considerable not to mention the great amount of suffering that might be avoided, largely because the physicians and surgeons of the state do not have it impressed upon them that cancer of the colon and rectum is a disease of importance, because it can be treated with considerable success. It would not be a wild dream to believe that more than 75 per cent of all cases would be suitable for radical operation if general interest could be aroused, but, of course, it is useless to expect any sudden change in the interest shown in these cases or in the ability to diagnose them. The surgeon must first become interested in these cases in order to stimulate others. He must show physicians that he can operate with a reasonable mortality and must be able to show that patients live comfortably for a reason-

in the stool is of little or no value in diagnosis to the average physician or layman

If all schools could send their students out with the idea that bleeding from the rectum means carcinoma of the colon or rectum until it is definitely proved in a particular case that it is not, a great advance would be made. I asked a class of 100 students the other day the most important cause of bleeding from the rectum and was told that it was hæmorrhoids.

Much has been said recently about bleeding in cases of diverticulitis of the colon. So far as can be made out from statistics, bleeding associated with diverticulitis of the colon alone occurs in about 5 per cent of these cases. It is evident, therefore, that great care must be taken to avoid overlooking carcinoma of the colon when there has been bleeding and a diagnosis of diverticulitis has been made by X-ray. In my own cases if I had depended on the X-ray diagnosis of diverticulitis with bleeding, an error would have been made in 75 per cent of the cases, while if operation had been carried out in all these cases, the operation would have been an error in but 25 per cent. It is exceedingly dangerous to make a diagnosis of diverticulitis of the colon even with the aid of the X-ray when there is bleeding associated with it.

Symptoms which are still spoken of as of great importance are The "ribbon" stool, constipation, alternating constipation and diarrhœa, diarrhœa alone, loss of weight, and pain. The ribbon stool may be thrown out as of no value. Constipation in these days of oils often passes unnoticed. It may be true that there is alternating constipation and diarrhœa, but so long as the patient does not recognize it, why should we consider it of importance? The patient may become constipated, but if he does he frequently takes oil which relieves, usually without diarrhœa. At times the constipation may be more marked, he then takes a cathartic and has several movements which he attributes to the cathartic and he does not speak of it as diarrhœa, nor does he appreciate that it is alternating constipation and diarrhœa. When the growth is low or causing marked obstruction, there are often many small movements or the patient goes to stool frequently to get rid of mucus and usually blood, but he does not recognize this as diarrhœa. Loss of weight is of little value as a symptom as it rarely occurs until after the obstruction is marked. There is then at times loss of weight due to loss of appetite, but rarely loss of weight due to the disease. Pain does occur frequently, but it is before the patient reaches the physician usually. Later in the course of the disease the patient does not complain of pain, but will admit that there is much disturbance from gas, not pain. Occasionally there are repeated attacks of pain with comfort between the attacks. These are frequently overlooked or considered to be of no significance unless they are unduly prolonged. It will be seen, therefore, that many of the symptoms as given in the older textbooks are really of little value in making an early diagnosis.

If carcinoma of the rectum is suspected, the diagnosis can be made, in 100 per cent of the cases presenting themselves, by digital or sigmoidoscopic examination. I have no hesitation in urging that no X-ray examination be made

It is my opinion that more errors are made because of inability to see the whole surface of the rectum and lower sigmoid than for any other reason. It is not sufficient to have the bowel free from large masses of faecal matter, the mucous membrane must be carefully wiped in order not to see ulcerations where there are none. Ulcerative colitis has been reported when frequent movements with blood are present because of this error.

In the final summing up of a case in which carcinoma of the colon is suspected, it must not be forgotten that an exploratory operation is not a serious matter. We must not forget how easily we advise operation for a suspected chronic appendix or for a so-called chronic cholecystitis. It is of much greater importance to explore when carcinoma is suspected.

In regard to the treatment of carcinoma of the colon and rectum I feel that there should be some standardization or at least some agreement as to the fundamental principles of the treatment of carcinoma of the colon and rectum. I am quite in agreement with Doctor Turner when he said at the meeting of the American College of Surgeons last October "Personally I have a great distrust of so-called standardization in dealing with human beings and pathologic conditions." I feel, however, that we must agree upon certain fundamental principles. Another statement which Doctor Turner made in the same address proves the necessity for coming to some agreement. He said "The history of surgery of malignant disease is neither so discouraging nor so discreditable as many would have us believe, for it shows that when efforts of the surgeon have been sufficiently thorough, the results have often been commensurate with the sacrifice which the patient has had to make."

The fundamental principle to be settled is: What is a "sufficiently thorough" operation? This has been answered in the past and even up to the present time by two opposing groups. The first group states that carcinoma of the colon and rectum metastasizes late or not at all and therefore a local operation is sufficient. The second group believe that patients with carcinoma of the colon and rectum should be treated as are patients with carcinoma in other organs, that is, the growth should be excised by a wide margin and the area of lymphatic drainage removed with it so far as possible. It is quite evident that surgeons have never agreed upon what is "sufficiently thorough." Czerny in 1883 reported upon a combined abdomino-perineal operation for cancer of the rectum, but surgeons were not ready for so extensive an operation. In 1911, Miles, of London, after a careful study of cancer of the rectum, presented his combined abdomino-perineal operation for cancer of the rectum and gave excellent reasons for it. This brought forth a great many protests against such an extensive and mutilating operation and there were many statements similar to that of Doctor Paul, of Liverpool, who, in 1912, said "Why should we undertake an extensive excision of the mesentery for the removal of glands which in all probability are not infected?" One English surgeon some years later said that so far as he knew, all his cases were alive and well after excision by the posterior route. It is only rarely that I

that these regions are not involved in many cases as shown by results in the more extensive operations. Do we not have the supra-clavicular glands and the lymphatics of the breast connecting with those between the ribs as well as other channels, as pointed out by Sir Sampson-Handley? Do we perform a local operation on cancer of the breast because of these inaccessible lymphatics? Is it not reasonable that we should treat cancer of the colon and rectum as we do cancer in other parts? Is it not time that we considered this subject from the point of view of the results obtained by the various operations? Is it reasonable that we should consider the value of an operation from results in two or three cases when they have been selected from 100 or 125 as has been done in many reports on the lesser operations? Should we not determine by statistics the operation which can be done with a reasonable mortality and which gives us the largest number of patients out of the total number seen, who have lived three or more years?

These reports of small series of cases treated by local or restricted operations without stating the percentage they are of the total number seen are discouraging to those trying to improve results and to operate upon a larger percentage of cases, and it makes it difficult to do any operation other than the limited ones reported because physicians and patients hear of them and will not submit to the more extensive and, I believe, better operations in most cases. I have met one man who is at least honest in the matter. He admits that he amputates the rectum by the posterior route because his mortality is lower than with the more extensive operations, and as his mortality is lower, it makes a better impression on the community even though the late results may not be so good.

We must admit, I think, until statistics prove otherwise, that the more extensive operations which include removal of the area of lymphatic drainage are the ones which should be undertaken when possible and that the experience of the surgeon and the condition of the patient are the only valid reasons for a lesser operation, except in an occasional carefully selected case when the type and extent of the disease are determined by an experienced surgeon.

Professor Grey Turner, in his address, stated that he had done fourteen local resections for cancer of the rectum. Four died within a year and nine months and five have been operated upon less than three years. While this seems to be quite a series, Professor Grey Turner, in a personal statement, told me that this list comprised between 2 per cent and 3 per cent of the total number of operations for cancer of the rectum, not a large enough percentage to make local resection a very valuable operation and yet one which has been advocated by several surgeons as the operation of choice.

We should not object to a surgeon selecting the operation which he is capable of performing, nor the operation best suited to the condition present or to the ability of the patient to withstand any particular operation. We should object to the statement not backed by statistics that a lesser operation is as good as or better than a more extensive one. It may be true that there

In regard to the necessity for a colostomy in the great majority of cases, I believe that Turner, in his address to the American College of Surgeons, made a very significant statement when he said "When efforts of the surgeon have been sufficiently thorough, the results have often been commensurate with the sacrifice which the patient has had to make" If this statement is true of malignant disease anywhere, it is true of carcinoma of the rectum It may be a sacrifice to have a colostomy, but I thoroughly believe that the results are commensurate with the sacrifice This of course assumes that the surgeon will teach the patient how to care for the colostomy, as almost the only patients who complain of their colostomies are those who have managed them according to their own ideas, that is, with cathartics It is the duty of surgeons who operate upon carcinoma of the rectum to learn how to care for colostomies, for there is no mechanical method of controlling them in spite of all the operations that have been devised, and to learn from experience with patients their feelings in regard to colostomies, and not to allow sentimentality to keep them from doing a "sufficiently thorough" operation A colostomy is necessary in the great majority of cases The sphincter may be preserved in a small percentage only when the growth is quite early and the selection made by a man of great experience

Most physicians and many surgeons obtain their experience in regard to colostomies from those patients in whom the growth has not been removed Those who have had experience with colostomies after removal of the growth look upon them as a rule in an entirely different light I may say that after seeing about 300 patients who have had a colostomy and the growth removed I can state that I have not seen a patient who has not lived happily and contentedly I have never known a patient to commit suicide after removal of the growth and a colostomy, but I have known of two or more who have committed suicide who have not been operated upon

This is not a plea for the combined abdomino-perineal operation in every case, but a plea for a "sufficiently thorough" operation for every patient who can stand it It is my belief that the saying that the smaller and the earlier the growth and the better the chances for a cure, the more extensive should the operation be, holds good today as well as formerly

In dealing with carcinoma of the colon and rectum, I believe it is important for the surgeon to consider these cases from the point of view of making the patient comfortable rather than from the point of view of cure If we operated only upon those patients who we think can be cured, there will be a large number of patients who could have been made comfortable for one, three, or more years who will not be operated upon It is my opinion that comfort for one year is worth more than the discomfort of the operation

While it is not possible to standardize the technic in resections of the colon, two fundamental principles might be agreed upon (1) An adequate blood supply is a necessity, and (2) the line of sutures must be relieved of intra-intestinal pressure We have, I believe, spent too much time on the consideration of the suture material, aseptic methods of anastomosis, and the

make a colostomy a short distance above the line of suture, but we believe that a cæcostomy made by infolding the cæcum about a tube one-half to three-quarters of an inch in diameter is effective, never interferes with the field of operation, is sufficiently effective in emptying the bowel before operation and requires no secondary operation to close it

There are other methods of preventing pressure upon the suture line, but they are not so effective as a safety valve as the cæcostomy or colostomy. Morphia has much value in keeping down violent peristalsis and it is the simplest method. Proper preparation of the bowels before operation as suggested by Rankin has its value, but it cannot be depended upon alone in all cases. In low resections with end-to-end anastomosis a three-quarter inch tube may be put in through the anus and through the anastomosis, but to be effective, the bowel must have been thoroughly cleansed before operation. It is true that many patients have lived after resections when nothing has been done to prevent intra-intestinal pressure, but is that a good reason for continuing a procedure which may bring disaster in any case?

As to other points in technic, they are of so little importance as compared to a proper blood supply and the prevention of intra-intestinal pressure that they will not be taken up. It may be said that so much stress has been laid upon the aseptic method of anastomosis by some authors that the two important factors in good results, blood supply and absence of pressure on the line of sutures, have been lost sight of.

As to drainage following suture, there will always be a controversy. It may be said, however, that fewer cases are drained than formerly.

ture Berry and Legg in 1912 employed the Z-incision for adjusting the vermillion border in a poorly repaired congenital cleft of the lip

McCurdy in 1913, in 1917, and again in 1924 wrote on the Z-plastic method and emphasized the importance of implanting in the centre of the wounds flaps of normal skin and of shifting the burn scar to the ends of the field of operation Morestin in 1914 described a method of relaxing a permanent flexion of the finger due to scar tissue by the use of a multiple Z-incision An incision was made along the rim of the scar bridle dividing

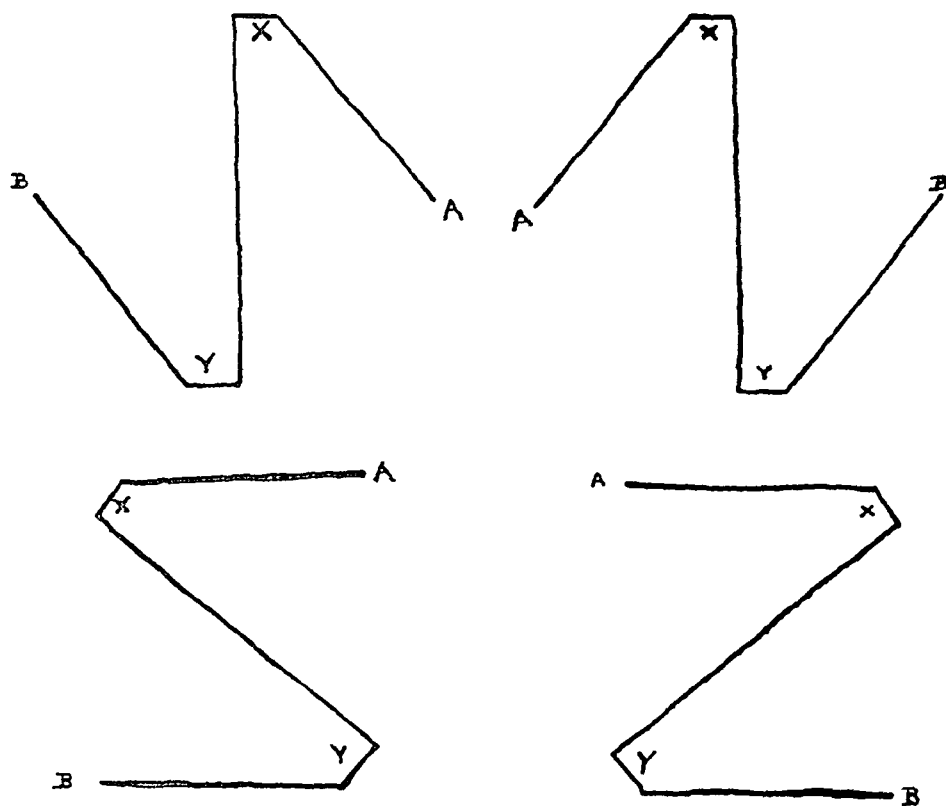


FIG 1—Illustrating the Z and reversed Z type incision In the diagrams the length of the corresponding lines making the incisions are the same although they appear to vary considerably on account of the tilt of the figure The longest line of the Z may be in any direction in which the scar contracture happens to be and the arms of the Z will necessarily change their direction to conform with this In each of the diagrams after the blunt pointed flaps outlined by the incisions are raised and transposed the tip X is sutured into the angle formed at B and the tip Y into that at A The line AX being sutured to the BY

it into two leaves, then from this central incision several lateral incisions were made forming a number of flaps The finger was straightened and the flaps were drawn into the angles formed by the incisions made on the opposite side In this way the scar bridle was released and the scar pull broken by a very irregular closure This procedure was well illustrated diagrammatically by Rahm in 1923

Frank S Matthews in 1915 illustrated a modified Z-type incision for liberating a band of scar tissue which was quite similar to that used by Piechaud, but was devised without knowledge of Piechaud's work Pieri in



1919 illustrated the application of a modified Z-type incision with the transposition of scar flaps in deepening the commissures on badly mutilated hands. Davis illustrates the Z-type incision several times in his book on Plastic Surgery, published in 1919, and also in a paper on Arm-Chest Adhesions in 1924. He again demonstrated the use of this method on the face and neck in 1930 in the Section on Plastic Surgery in Dean Lewis' System of Surgery.

Steindler in 1923 illustrated his idea of Pieri's operation in relaxing a scar web on the thumb by the use of a modified Z-type incision and also showed an excellent illustration of the relaxing of a web between the thumb and forefinger by a Z-incision. Bosch Arana in 1925 wrote on the use of a modified Z-incision with the transposition of flaps in the phalangization of



FIG 3a

FIG 3b

FIG 3c

Illustrating the use of the Z type incision on the neck.

FIGS 3a and 3b—Old burn scar of neck. Note the width of the bridge and the extent of the scar. In this case a Z shaped incision was made and the flaps were transposed.

FIG 3c—The result of this relaxation after twelve days can be seen. Note the complete relaxation of the scar bridge, the relief of tension and the satisfactory utilization of scar infiltrated flaps.

the first metacarpal. C. N. Dowd in 1927 published an article on the use of the Z-incision in the repair of cicatricial contractures of the neck. Babcock in 1928 illustrates nicely the use of the Z-type incision in what he describes as Pieri's operation for the relief of a web between the thumb and forefinger.

It is probable that the Z-type incision has been described in other articles which we have not mentioned, but there is no question but that it was used over seventy years ago, and that it has been frequently rediscovered and described as a new procedure.

*Technic*—It is with those contractures which present a prominent bridge or web with which we most frequently have to deal, but the method is also very effective in dealing with the type of contracted scar whose contracted portion sinks into a groove and has a deep attachment instead of projecting as a bridge or web. This latter type of contracture is, of course, much less commonly found.

out except that the long line of the Z splits the groove lengthwise and the flaps are formed just as when a bridle is present

*Comments*—The treatment of burns and other extensive surface lesions which frequently result in contractures will not be considered except to say that every effort should be made to induce rapid healing with the part in proper position, as in this way excessive scar formation and subsequent contractures may be minimized. Some contractures may be avoided by very careful treatment of the original lesion, but my experience has been that contractures may and will occur in spite of every precaution. These con-



FIG 5a



FIG 5b

Illustrating the relaxation of a scar involving the axilla and trunk by the Z type incision

FIG 5a—Burn scar of many years duration. Several operations had been done previously. Note the condition in the axillary space and the dense scar extending from the axilla to the pelvic brim.

FIG 5b—Result after two months. Note the release and smoothing out of the axilla in spite of the fact that the tips of both flaps sloughed. Also note the relaxation of the entire scar on the trunk by the Z incision which now allows much greater freedom of motion. These flaps were composed entirely of thick scar tissue and it can be seen that they survived throughout.

tractures are found most frequently in the axilla, where the extremities join the trunk, around joints and on the neck and face.

As a general rule, it is advisable to delay operative work on contracted scars until nature, assisted by massage and passive motion, has had time to do all that she can. A few months will make a great deal of difference in the condition of the scar and of the surrounding tissues and by making haste slowly useless operations may be avoided, so that when we finally come to operate we will be able to see the scar as it eventually will be and can take steps to properly correct it.

This brings up the importance of the age of the patient with a scar contracture. During the growing period scar contracture, if not relieved, may materially interfere with the growth of the bony structure as well as of the



Illustrating the use of the Z type incision for the relief of scar contractures in the axilla cubital space and at the wrist

FIG 7a—Scar contracture following a burn. Note the involvement which extends from the chest to the hand. Some operative work had been done elsewhere before the patient came under my care.



FIG 7b—Result after two weeks, of relaxation at the wrist and in the cubital space

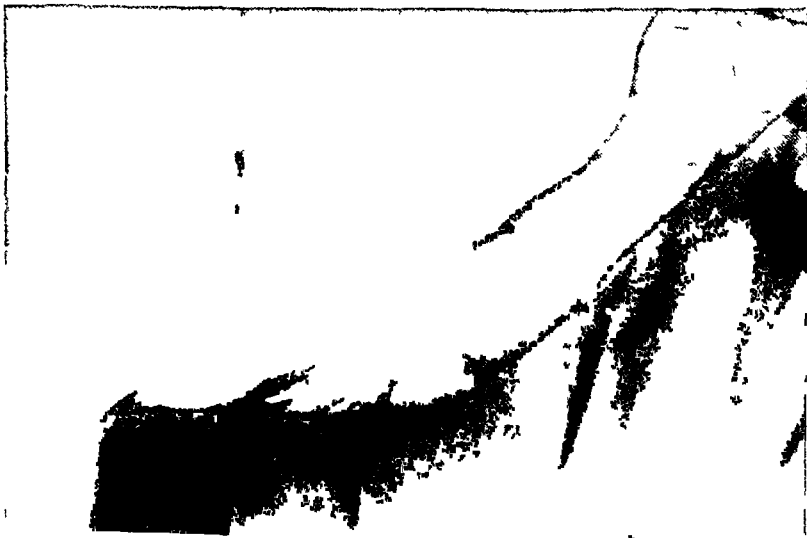


FIG 7c—The same arm after two years. During the interval further relaxation had been done on the axilla. Note the improvement in extension at the elbow and wrist

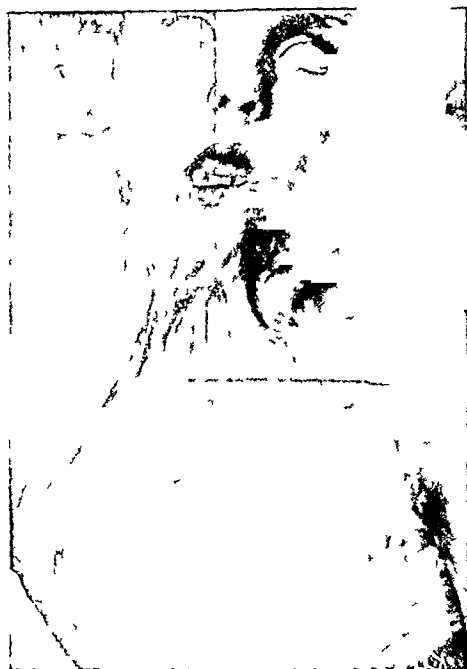


FIG 8a



FIG 8b

Illustrating the Z type incision used several times in the same area for relaxing scar contraction  
FIGS 8a and 8b—Extensive very thick burn scar of neck chest and axilla Note the extent and character of the scar



FIG 8c—Result after eight months of the first use of the Z type incision on neck and axilla. Note the difference in the character of the bridge and how much thinner and less dense it is. The Z type incision was again used on the neck and in the axilla

bridle is thick and hard and is unpromising for use, then an elongated ellipse of tissue including this portion is excised and the edges are brought together with a few temporary sutures. The Z or reversed Z is then marked out, the incisions are made and the flaps are raised and transposed in the usual way.

The lines marking out the prospective flaps may vary considerably in shape and direction according to the pull of the contracture and the type of the surrounding tissue, and in this way many modifications of the Z-incision may occur. In planning flaps care must be taken to utilize the best available tissue and for this reason the incision may be a Z or reversed Z depending on whether there is less infiltration with scar to the right or to the left of the line of contracture and above or below a transverse mark dividing this line. In other words, if the tissue is less infiltrated with scar in the upper left quadrant and in the lower right quadrant (facing the patient), then the Z is used and vice versa. The contraction pull of the scar on the two sides of a central bridle may be quite different and consequently after the flaps have been formed and undercut, they may be drawn entirely away from the anticipated position. In these instances, readjustments by properly placed secondary incisions may be necessary and must be carried out before the desired relaxation can be obtained and the wound closed.

In a wide scar bridle, relaxation may be secured in more than one place, or in more than one direction by the use of the Z-incisions. In long contractures, say from the buttock to the ankle, I have used three or four of these relaxations at one operation, before the contracture was completely relieved. This was possible as there was sufficient tissue between the selected areas to prevent interference with the circulation of the flaps already made and transposed.

Should scar bands be found deep in the tissues after raising the flaps, they should be either divided or better still removed, and all tension relieved before the flaps are transposed and sutured. The flaps should be handled with small sharp dural hooks to avoid bruising. The sutures should be of horse-hair threaded on fine half-curved needles and only enough should be put in to approximate the edges. All tension on the flap should be avoided.

The tips of the flaps should be made blunt instead of pointed, as when thus made they are much less liable to slough. Even if the tips of the flaps do slough, which sometimes happens when there is much scar, we often find that sufficient relaxation has been accomplished and that soon the defect left by the sloughing tips will be filled up and the scar will become smooth again. It is advisable to have the flap as thick as may be, including some subcutaneous fat if it is present, in order to conserve the circulation. Should the tips of the flaps become bluish after a few hours of the sponge pressure, it is advantageous to apply continuous compresses saturated with normal salt or boracic-acid solution.

I have used the Z-incision for the relief of tension in fairly broad tight scars with considerable success. In the relief of congenital webbing of the neck, the Z-incision with the transposition of flaps is the method of choice.

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used as a basis on which deeper anæsthesia may be produced with the gases or ether. This has been called basal anæsthesia.

*Absorption and Elimination*—Avertin is absorbed by the intestinal mucosa more rapidly than is the water in which it is dissolved. The absorption is fairly rapid, 80 per cent in the first twenty minutes and 95 per cent within the first two hours.

If unduly deep anæsthesia occurs within the first twenty minutes, the rectum should be evacuated by washing with water. This not only rids the bowel of the avertin solution, but also dilutes it and delays absorption of that which remains.

Detoxification occurs by combining with glycuronic acid in the liver and it is eliminated in this manner almost entirely by the kidneys.

Adrenalin and salt solutions are effective in combating marked falls in blood pressure. Carbon-dioxide-oxygen mixtures may be used in stimulating respiration.

*Action*—There is apparently no local action. Sleep comes on gradually without excitement in from ten to thirty minutes. There is no recollection of induction. The ocular reflexes disappear, and with the average dosage the pupils are contracted and react to light.

*Duration of Anæsthesia*—In most cases the patient sleeps soundly for approximately two hours after induction. For the next three to four hours the sleep is light and intermittent. Nursing care is important at this time in maintaining a clear airway.

The respiratory rate is increased and the depth decreased.

The pulse rate approaches the normal. There is usually a fall in the blood pressure. There have been four cases with marked falls in blood pressure without apparent shock.

It appears that avertin acts in a different manner upon the brain than the anæsthetics in common use. In cases in which major surgery was performed and in which no general anæsthesia was necessary, it appeared that impulses reached the brain. This was made evident by perspiration, with change of temperature of the skin, an increase in the pulse rate, and a fall in blood pressure.

However, in these cases, there was also satisfactory relaxation.

In minor procedures, these symptoms were not apparent. Because of these untoward effects, it is a better procedure to combine avertin with ethylene-oxygen or nitrous-oxygen, or ether. These combinations afford satisfactory anæsthesias of moderate depth.

No adaptive response is excited by the anæsthetic. There is a minimum of disturbance to the sensory mechanism and mentality, hence there is a minimum of shock.

It is impossible to estimate the amount of damage done by the psychic shock produced in some patients, particularly in children, immediately preceding and during induction of anæsthesia.

Anæsthesia in pediatric surgery has always been difficult. It has been

## AVERTIN ANÆSTHESIA\*

FROM THE SURGICAL STANDPOINT A RÉSUMÉ OF EIGHTEEN MONTHS'  
EXPERIENCE

By CHARLES S WHITE, M D

OF WASHINGTON, D C

THE evolution of the administration of ether, from the paper cone and simple can, to the present day battery of tanks and valves, has taken place in a comparatively few years. The search for the ideal and universal anæsthetic, like the brook, goes on, and has brought to light several new and valuable agents, each with some particular virtue and some particular sin.

In the following recitation of our personal experience with avertin, we shall not enter into a discussion of the relative merits of the various anæsthetic agents, as it would open a contraversial subject. Each surgeon regards his favorite anæsthetic very much in the same way that the indulgent parent regards his child, and no good could possibly be accomplished by a comparative analysis.

Our experience with avertin began in August, 1929. Our first patient was a muscular negro who was given the German dose, that is, the dose recommended in the German Clinics in 1927 and 1928. The promptness with which the patient went to sleep, and the depth of anæsthesia which followed, convinced us that avertin at least had possibilities.

We secured the help of two veterinarians and at their hospital had them do a few operations and readily found the surgical and lethal dose of the drug in dogs. From that time we felt that we had a fair estimate of the maximum dose and it was not long before we had a working formula which we still use, although it is not as accurate as we would desire. We have used avertin in more than one thousand cases and still continue to use it routinely.

Doctor Kreiselman has discussed avertin from the anæsthetist's standpoint, and we shall stress the clinical manifestations, rather than the administration and physiologic actions. The induction has been uniformly quiet, and nothing approaching a mania has been seen in a single case. Occasionally, the patient becomes loquacious and hilarious but never combative, and sleep follows within ten minutes.

In a few medical students one of our friends timed them for loss of memory after the introduction of avertin, and it was found that consciousness was lost after three minutes, although several of them spoke intelligently for two or three minutes longer. It may be a peculiar trait of medical students to be intelligent when they are apparently unconscious. My experience has been just the opposite.

In about 2 per cent of the cases, the patients reacted excitedly, just as we

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\*Read before the Philadelphia Academy of Surgery, May 4, 1931



E Lee, the so-called ether pneumonia has been replaced by atelectasis, or collapse, and just what part the anæsthetic plays in this, we confess our ignorance. Our experience leads us to say that collapse of the lung has been more frequent after spinal anæsthesia, than any other, but our cases have been too meagre to be of any real value in estimating the relative frequency. We have had post-operative elevation of temperature cough and expectoration of various degrees of severity after avertin anæsthesia. These cases were not X-rayed before and after operation and, in most instances the diagnoses were not conclusive. The roentgenologist and internist have not completely agreed and it is impossible to state the relative frequency of lung complications following avertin. One thing is certain, the incidence has not increased. Some of the cases were a concern for merely a day and four were quite ill, but no mortality followed from that cause. We feel that this question is still debatable and considerable research is necessary before the relation of the anæsthetic to pulmonary collapse can be rationally discussed.

We have not hesitated to use avertin in cases of chronic pulmonary tuberculosis and have seen no ill effects.

As avertin is not a renal irritant, we should expect no untoward effects after its use in a patient with normal kidneys, as we estimate normal kidneys by urinalyses. Our experience bears this out. We have not found any serious aggravation of a mild nephritis after its use, if we believe that a trace of albumin and a few casts are indicative of kidney disease. With a seriously impaired renal function we question the propriety of any general anæsthetic.

As the liver bears the brunt of avertin disintegration, it is the organ that should suffer most following the administration of this anæsthetic. This is probably true, but has not been brought home to us by actual experience. The liver will meet the demands of the body when the entire organ is almost replaced by a neoplasm. It seems endowed with a superhuman metabolic mechanism. It stands abuse almost as well as the stomach, and it is for that reason, perhaps, that we have failed to notice toxicity of hepatic origin after the use of avertin. In one instance we put it to a test. A patient with advanced carcinoma of the liver had a strangulated hæmorrhoid and we elected to relieve him under avertin anæsthesia. His expectancy of life was very brief and we are sure that both the patient and the family would have been grateful for an earlier end. The anæsthetic put him to sleep promptly and the operation was satisfactorily done. The atypical aftermath was the delirium, which lasted three days.

There are said to be two contra-indications to the use of avertin. Serious impairment of liver function and ulceration of the rectum. It is apparent why it should not be used in a case of damaged liver, and it is not used in an ulcerated bowel, because it will not be absorbed promptly, even if it is retained. These contra-indications should be accepted until confirmed or disproved by further use of the drug.

# THE RESULTS OF AVERTIN BASIS ANÆSTHESIAS, WITH ETHER, NITROUS OXYGEN AND ETHYLENE—BASED ON CLINICAL AND METABOLIC STUDIES—REPORT OF 700 CASES

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THE standard for any kind of anæsthesia used in surgery should provide, as far as possible, for the safe exclusion of pain and psychic disturbance of the patient in order to make the operation a success

The following paper has to deal with 700 cases of avertin anæsthesias with the idea of ascertaining how far we are able to fulfill these postulations

Out of 1,750 operations in one year, 700 operations were carried out under avertin anæsthesia. Hence, it is clear that not all cases are adaptable to avertin and that the principal indication for every anæsthesia has to be made for each patient individually. In other words, the surgeon has to decide for every single case which form of anæsthesia is best adapted to each patient. Therefore, it is necessary to bear in mind the general condition of the patient, heart and lungs and state of shock, *etc*. If the circulatory system is weak, then avertin anæsthesia is contra-indicated. Furthermore, in our hospital, complete avertin anæsthesia without supplementary measures is not used. By the results and experiences of the German authors there is shown that doses of avertin, needed for a complete anæsthesia without supplement, are too large and too toxic so that it is not advisable to force a complete avertin narcosis (Rehn and Killian<sup>27</sup>). Such a complete narcosis with the toxic, non-controllable avertin does not correspond with the biologic laws of the organism, particularly not with those of the diseased organism.

Here, therefore, we are dealing only with the avertin "basis narcosis" (Straub<sup>30</sup>) and its combination with ether, nitrous oxygen ( $N_2O$ ) and ethylene ( $C_2H_4$ ), the latter two being combined with oxygen.

First, there is a brief note necessary as to the principal fundamentals of the supplements used in order to compare their effect and biologic reaction in combination with avertin.

*Ether*.—Ether acts as a stimulant to blood-pressure, especially at the beginning of its administration, while avertin has a tendency to decrease the pressure. Blalock and Franken<sup>12</sup> have called attention to the increased heart effort due to a specific heart reaction caused by the ether. By increasing or decreasing the ether blood concentration, one can readily control and regulate the respiration, and hereby accomplish an individual deep or light anæsthesia. Anschuetz<sup>3</sup> states that there is a "favorable influence of ether on blood-pressure and respiration, when avertin is combined with small amounts of ether," and it doubtless compensates in part for the severe drop of blood-pressure, which is as a rule the case after using avertin.

oxide or ethylene is used as a supplement before operation. If, in a single case, the supplement with  $N_2O$  is not sufficient, then one can change or combine  $N_2O$  with ether, which is easily done by the use of the Foregger or McKesson machine. In such a way one can control and steer the avertin basis narcosis with a larger or smaller amount of ether or gas supplement. This clinical statement is founded on the pharmacologic investigation of Straub,<sup>30</sup> Lendle<sup>18</sup> and also on the clinical reports of White,<sup>33</sup> Parsons,<sup>25</sup> Lundy,<sup>24</sup> Guttman,<sup>13</sup> Speidel<sup>29</sup> and others.

In 700 such cases avertin basis narcosis was employed and combined with ether or gas without fatality and with very satisfactory results. There is a definite blood-pressure effect with avertin (an average drop of 30 to 40 milligrams mercury). Immediately after the ether effect and likewise after gas, a certain rise of blood-pressure is always the case. The blood-pressure curve shows better results after these mixed anaesthetics than after a complete avertin anaesthesia. In some cases, ephedrine was given with the avertin enema to prevent the drop of blood-pressure, as ephedrine is absorbed by the mucous membrane, with and sometimes without results. We should, nevertheless, bear in mind that after other anaesthesia methods, a drop of blood-pressure is known to occur, for instance, after spinal anaesthesia (Pitkin) and after caudal anaesthesia (Widenhorn<sup>34</sup>).

Then, too, we must not neglect the fact that independent of the anaesthesia, a decrease of blood-pressure may result from the operation itself (pulling the peritoneum or the splanchnic nerve or the pedicle of the kidney, *etc.*).

The pulse shows generally a reasonable elevation and remains at this level and rises on the average of 100 to 110 pulsations a minute. Ether and gas have an increasing influence.

The respiration during this combined method is essentially more favorable than after complete anaesthesia. The statement of Puckner's<sup>26</sup> "Avertin depresses the respiratory centre, lessening both frequency and volume," is correct for the complete avertin anaesthesia. In the majority of our cases, our protocols of the frequency and breathing per minute are the same in the beginning, during and at the end of the anaesthesia, usually 20 to 22 respirations per minute.

During each of the 700 anaesthetics the blood-pressure, pulse, and respiration were measured at intervals of five minutes.

The amount of the supplementary anaesthetic depends on the following: (1) On the amount of the single dose (milligram avertin per kilo). (2) On the amount of the whole dose (cubic centimetre per patient). (3) On the type of operation. (4) On the time of operation. (5) On the individuality of the patient, as every patient requires an individual amount of avertin as well as of ether and gas.

Furthermore, the post-operative sleeping time after these anaesthetics was studied. One can differentiate between a first and a second sleeping time. The first one is counted until the patient first awakes, when the patient first reacts, responds and is able to speak. The second sleeping time includes

CO Combining Power Blood Sugar in Mgrs Per Cent

Sex	Age	Diagnosis	Operation	Time of Operation in Minutes	Avertin in Cc	Ether in Cc	8 Hrs				24 Hrs			
							Before Opera- tion	After Opera- tion	After Opera- tion	Before Opera- tion	After Opera- tion	After Opera- tion	After Opera- tion	After Opera- tion
F	29	Hernia abdominal wall	Laparotomy	90	5 85	57	53 2	49 4	46 6	95	49 4	49 4	120	75
M	15	Fibrosarcoma of thigh	Amputa femur, remov glands	120	3 5	120	58 9	48 5	51 3	95	54 1	54 1	148	110
F	24	Ing hernia	Bassini	60	7 0	150	59 5	51 9	50 4	86	61 3	61 3	130	95
M	58	Carc lip, metas glands	Excision, plastic, remv glands	150	5 4	120	50 4	59 4	50 4		53 2	53 2		
M	45	Ing hernia, buat- eral	Bassini	150	5 4	200	64 5	50 4	58 9	95			155	105
M	57	Carc ear, metas glands	Excis plastic, remv glands	180	6 4	150	55	54 1	55 7		63 0	63 0		
F	34	Exop goitre	Part lobect	90	5 3	150	48 5	38 1	49 4	72	44 7	44 7	100	110
F	44	Exop Goitre	Doub par lobect	120	4 3	180	54 8	50 0	51 9	100	54 8	54 8	140	105
M	35	Ing hernia, bilateral	Bassini, bilateral	150	5 0	180	55 0	54 1	49 4		53 2	53 2		
Gas														
Nitrous Oxide														
Ethylene														
F	54	Adenoma of thyroid	Excision of adenoma	60	6 6	N <sub>2</sub> O	54 8	55 7	51 3	110	52 2	52 2	125	110
F	29	Pyosalpinx, append- chron	Laparotomy, appen- dectomy, ovaric- tomy	150	4 3	N <sub>2</sub> O	59 5	56 7	59 5	105	50 5	50 5	152	115
F	54	Carc breast	Rad operation	150	4 9	N <sub>2</sub> O	61 7	57 9	51 3	60			96	100
F	63	Cholelithiasis ulcers stomach	Cholecystectomy, gastroenterostomy	160	4 6	N <sub>2</sub> O	53 2	43 8	47 5	60	49 4	49 4	148	135
M	51	Exoph Goitre	Double partial lo- bectomy	120	4 9	C <sub>2</sub> H <sub>4</sub>	52 8	51 0	51 0	100	51 8	51 8	120	115
F	41	Fibroma of breast	Amputa of breast	75	4 3	C <sub>2</sub> H <sub>4</sub>	53	57 0	59 8	100	58 9	58 9	115	105

- <sup>10</sup> Domanig Individuelle Dosierung der Avertinbasalnarkose Zentralblatt f Chir, No 35, S 2191, 1929
- <sup>11</sup> Floerchen, and Mues Deutsche Zeitschrift f Chirurgie, Bd ccxvii, 1930
- <sup>1</sup> Franken Die Allgemeinnarkose Berichte ueber die ges Gynäkologie Geburtshilfe u Grenzgebiete, Bd xv, Heft 6, 1929
- <sup>12</sup> Guttman Rectal Narkosis with Avertin Anæsthesia and Analgesia, vol ix, No 6, p 279, 1930
- <sup>13</sup> Henderson, and Haggard Journ of Biol Chem, vol xxxiii, 1918
- <sup>14</sup> Killian Zur pharmakologischen Wirkung von Avertin Zentralblatt f Chir, No 32, S 1997, 1927
- <sup>15</sup> Killian Ergebnisse mit der Avertinnarkose Narkose u Anæsthesie, No 1, S 16, 1928
- <sup>17</sup> Killian Weitere experimentelle Erfahrungen mit Avertin Narkose u Anæsthesie, No 3, S 119, 1928
- <sup>18</sup> Lendle Experimentelle Untersuchungen ueber Dosierung u Elimination des Avertins Narkose u Anæsthesie, No 5, S 239, 1928
- <sup>19</sup> Lendle Ueber die Bedingungen der Basalnarkose bei kombinierten Narkoseverfahren Klin Woch, No 35, 1930
- <sup>20</sup> Lendle Archiv f exp Pathol, vol cxliv, heft 1/2, S 76, 1929
- <sup>21</sup> Lendle, and Tunger Klin Woch, No 28, S 1923, 1930
- <sup>22</sup> Luckhardt, L, and Carter Ethylene as a Gas Anæsthetic Jour Med Assoc, vol lxxx, p 144, 1923
- <sup>23</sup> Luckhardt, and Lewis, Dean Clinical Experiences with Ethylene Oxygen Anæsthesia Jour Amer Med Assoc, vol lxxxi, p 1851, 1923
- <sup>24</sup> Lundy Staff Meetings of the Mayo Clinic, vol iv, p 324, 1929
- <sup>25</sup> Parsons Avertin Brit Med Jour, No 3639, p 554, 1930
- <sup>26</sup> Puckner Preliminary Report of the Council Avertin Jour of the Amer Med Assoc, vol xc, No 19, S 1427, 1930
- <sup>27</sup> Rehn, and Killian Indikationen der Schmerzbetäubung im Druck
- <sup>28</sup> Rehn Deutsch Med Wochenschrift, S 2003, 1928
- <sup>9</sup> Speidel Avertin Basal Anæsthesia Clinical Observations Report of 80 Cases
- <sup>30</sup> Straub Rectalnarkose Resorption u Dosierung Muench Med Woch, No 14, S 593, 1928
- <sup>31</sup> Straub Ausscheidung u Nebenwirkung Muench Med Wochenschrift, No 30, S 1279, 1928
- <sup>32</sup> Van Slyke, Austin, and Cullen Jour of Biol Chem, vol liii, 1922
- <sup>33</sup> White, Charles, and Kreiselmann Avertin Anæsthesia Surg, Gynec, and Obstet vol li, No 3, p 361, 1930
- <sup>34</sup> Widenhorn Deutsche Zeitschrift f Chir, Bd ccxvi, S 163, 1929
- <sup>35</sup> Wymer Saeure-Basenverhaeltnisse bei der Rectalnarkose Ztbl f Chir, No 39, 1927
- <sup>36</sup> Wymer, and Fuss Saeurebasenverhaeltnisse bei der Aether-Chloroform und Avertin-Narkose Narkose u Anæsthesie, No 6, p 283, 1928

about the method are most critical as to the indications for its employment. These early bad results are even now a basis for much skepticism and still somewhat overshadow the increasingly good results. In 1904 stovaine was introduced and was soon popularized, especially by Babcock<sup>8</sup> in America. His results were remarkably better than any previously obtained, but were still not all that could be wished. His recent good results have, however, become outstanding. During the past few years renewed interest in spinal analgesia has been manifested, no doubt due in a large part to the commendable work of Pitkin,<sup>9</sup> and to the availability of ephedrine with which to prevent alarming lowering of the blood pressure. With the present wave of enthusiasm has come the usual number of rediscoveries of variations of technic and application of spinal analgesia. Koster<sup>10</sup> has enthusiastically revived the procedure which in 1910 Jonnesco<sup>7</sup> said was "a new one and altogether distinctive, because I have generalized spinal anæsthesia, adopting it to all operations on any part of the body."

*Advantages*—The surgeon who has used spinal analgesia is always reluctant to dispense with it. The advantages are manifold. Granting that the prime requisite of all anæsthetics is safety, spinal analgesia can be made safe and therefore allow the patient and the surgeon to be benefited by its advantages. Pre-operatively, patients need not be denied fluids unless the type of operation contra-indicates it. Effective prophylaxis of acidosis can, therefore, easily be continued uninterrupted. In emergency operations not infrequently the pre-operative treatment must of necessity be reduced to a minimum. Spinal analgesia will often prove to be a choice method under these circumstances.

Some patients are distressed by the anticipation of loss of consciousness and are particularly grateful for some anæsthetic method other than general anæsthesia. The patient who has on different occasions had inhalation anæsthesia and spinal analgesia expresses a most critical opinion. It is significant that such a patient almost invariably elects spinal analgesia when a third operation must be performed. The surgeon who is accustomed to operating upon patients under inhalation anæsthesia is particularly impressed with the surprising ease with which he can accomplish most of the steps of the operation when using spinal analgesia. Relaxation is more complete than can be obtained even by deep ether narcosis. Retraction of an abdominal incision is hardly necessary. The intestines are contracted and fall away from the abdominal wall so completely that gauze packs are rarely needed even for operations requiring wide exposure of the operative field. Respiration is quiet, and unaccompanied by coughing or straining, thereby allowing the surgeon to work unhampered by extraneous movements. Operative procedures are facilitated and trauma is minimized. Very soon after operation the patient can be allowed to take fluids. Nausea or vomiting is infrequent. Post-operative distention is not unusual after inhalation anæsthesia and is always an annoying and frequently a disastrous complication if it occurs. Distention is rarely observed after spinal analgesia. Peristalsis is augmented

not been observed recently as new, less toxic drugs have been more carefully employed

*Contra-indications*—Spinal analgesia can be safely employed routinely to produce analgesia below the diaphragm with few, yet very definite, exceptions. The margin of safety is never great, and to disregard contra-indications is to invite disaster. Patients must be selected for spinal analgesia only after careful individual consideration. A careful history must be taken and a thorough examination made to elicit and evaluate factors which might contra-indicate spinal analgesia. Anæsthesia for imperative operations is often a difficult problem. Shock is frequently present, and the risk is great regardless of all precautions. The uninitiated may feel that in a "bad risk" case spinal analgesia is the method of choice. Any patient in shock tolerates spinal analgesia poorly and in such cases with acute shock or hæmorrhage spinal analgesia should not be administered. Such patients would, however, tolerate inhalation anæsthesia equally as poorly, and if some operative intervention is imperative, it could be more safely performed with local or regional analgesia. Indeed there are few indications for operations being done in the presence of shock. If the shock is relieved, spinal analgesia may safely be employed.

Patients with hypotension have previously been considered unsuited for spinal analgesia. This is generally true only if the hypotension is "acute" as from shock or hæmorrhage, which has been mentioned previously. With appropriate doses of ephedrine hypotension should not prove an absolute contra-indication. The author has repeatedly employed spinal analgesia successfully in patients whose systolic blood pressure was less than 100 millimetres of mercury.

Extreme cardiac decompensation and decreased vital capacity contra-indicate inhalation anæsthesia as well as spinal analgesia. The surgeon must, therefore, use local analgesia if operative procedures are imperative. Acute central nervous system disease, brain or spinal cord tumor, or neurosyphilis are reasons for not using spinal analgesia. Septicæmia is a contra-indication to spinal puncture and localized abscesses or ulcers at the site of puncture obviously prevent the introduction of a spinal needle.

All of the contra-indications cannot be considered here, but if spinal analgesia is to be employed successfully, contra-indications cannot be too carefully and honestly weighed in each individual case.

*Indications*—As is true in other surgical procedures, the individual's adeptness is an important factor in answering the question as to when spinal analgesia should be used. Surely those who use spinal analgesia frequently have safely widened its field of application, and perhaps there should be less criticism of this extended scope of indications when thus used with expert efficiency. Spinal analgesia has met its severest trials because so many surgeons have reserved it for use in "bad risk" cases. The elderly, emaciated patient has been the characteristic type for which spinal analgesia has been

so contracted that the operation can be speedily performed with a minimum amount of trauma

Spinal analgesia is of value in obstetrics. The author has had occasion to use this form of anæsthesia in several cases and has been impressed by the favorable results. A special technic must be employed, however, and a report of these cases will be made later. In this series, the only use in obstetrics recorded is that of cæsarean section.

*Accompanying Phenomena*—Spinal analgesia is induced by introducing the drug into the spinal fluid which bathes the intradural tissues and hence brings the anæsthetic solution into direct contact with the nerve roots. The

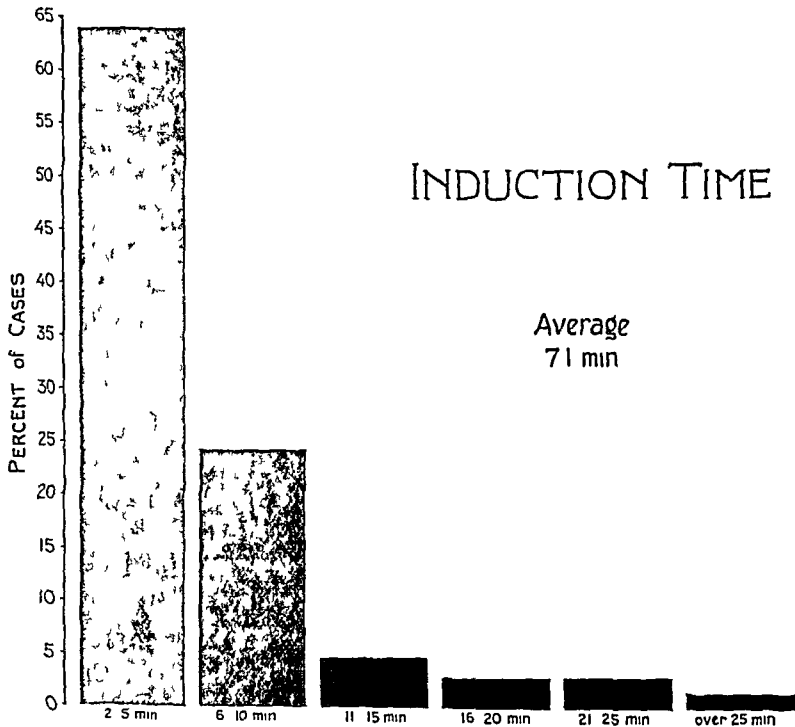


CHART I—As is shown by the blocks, almost 90 per cent of the spinal analgesias were induced within ten minutes. The small per cent requiring a longer period of time represent those cases in which a second injection was necessary.

drug is quickly absorbed by the nerve roots both in the spinal canal and for about two centimetres beyond their exit. Analgesia cannot be established gradually by slowly administering the drug, but occurs at once from a single injection and cannot be diminished. Also, if analgesia is insufficient, it cannot be increased except by a second injection. The cord itself is probably not very deeply penetrated by the analgesic drug. If the analgesic agent is held in a restricted area, the nerves thus bathed by the concentrated solution will be permeated quickly and diffusion will be prevented. If wide diffusion occurs, the drug will be most effective at the point of injection, but at no point will there be deep penetration of the roots, and the duration of analgesia will be expectedly less or may be insufficient. If a large dose of such



toxicity is therefore of secondary importance to the more critical question of diffusion of the drug in the cerebrospinal fluid. Lowering of the blood pressure occurs in almost exact proportion to the height of the spinal analgesia. In order to facilitate operations in the upper abdomen, it is necessary to produce an intraspinal block to the level of the seventh thoracic segment. No severe and uncontrollable vascular or respiratory symptoms should result from such a procedure, and appropriate doses of ephedrine given prior to the induction of analgesia efficiently prevent any alarming fall of blood pressure. If analgesia is required for operations below the level of the umbilicus, analgesia of the spinal nerve roots is needed only to the level of the tenth thoracic

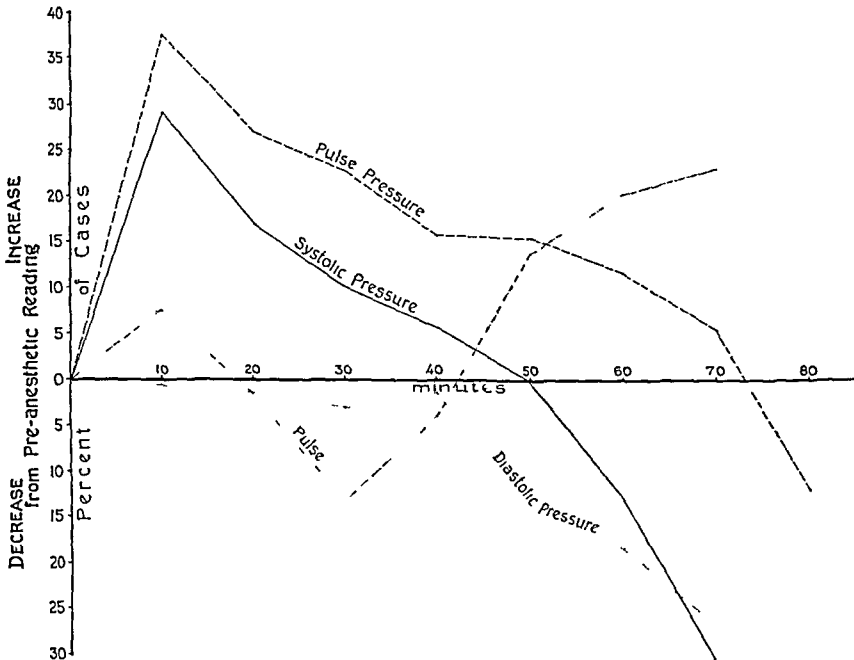


CHART II—These curves are drawn from determinations on 357 cases of spinal analgesia induced with spinocain. The curves illustrate what is known clinically *viz*, that the systolic blood pressure is increased at the early part of the anesthesia and gradually falls as the operation progresses and shock is superimposed upon the anesthetic. At fifty minutes it is seen that the systolic pressure is decreased sharply. A decrease at this late period must be attributed to operative trauma. The diastolic pressure shows very little change until the systolic pressure drops sharply when it shows a similar drop. The pulse is slightly accelerated at first no doubt due to the use of ephedrine and then remains slow for forty five minutes and then shows a marked increase in longer operations. The pulse pressure is seen to behave very similar to the systolic blood pressure.

segment. Only a very slight degree of vasomotor depression should accompany such an analgesia. Operations below the iliac crests can be performed with analgesia to the level of the first lumbar segment, and perineal operations may be successfully done by blocking only those nerves which leave the dural sac in its caudal tip. In either instance the systemic reaction is negligible.

*Drugs and Technics Used*—The consideration of the diffusion of the analgesic drug has always been paramount. Bier recognized this fact and early experimented with cocaine, but had only mediocre success. Fournieu<sup>13</sup> discovered stovaine in 1904, and as this drug proved to be less toxic than

probably works most efficiently when mixed with common sense and a thorough knowledge of the phenomena accompanying spinal analgesia

*Analysis of Cases*—The author has used crystalline novocaine dissolved in spinal fluid as has been stated, in a previous report,<sup>21</sup> and although the results were not unsatisfactory, certain undesirable features were evident. The short duration of the analgesia with novocaine crystals was a serious handicap. Control of the level of analgesia was only relative. No serious complications developed, however, and no deaths occurred. Recently, Pitkin's method has been adopted and the last 357 consecutive spinal analgesias have been induced according to his technic. There seem to be some outstanding advantages. There has been no difficulty in limiting the level of

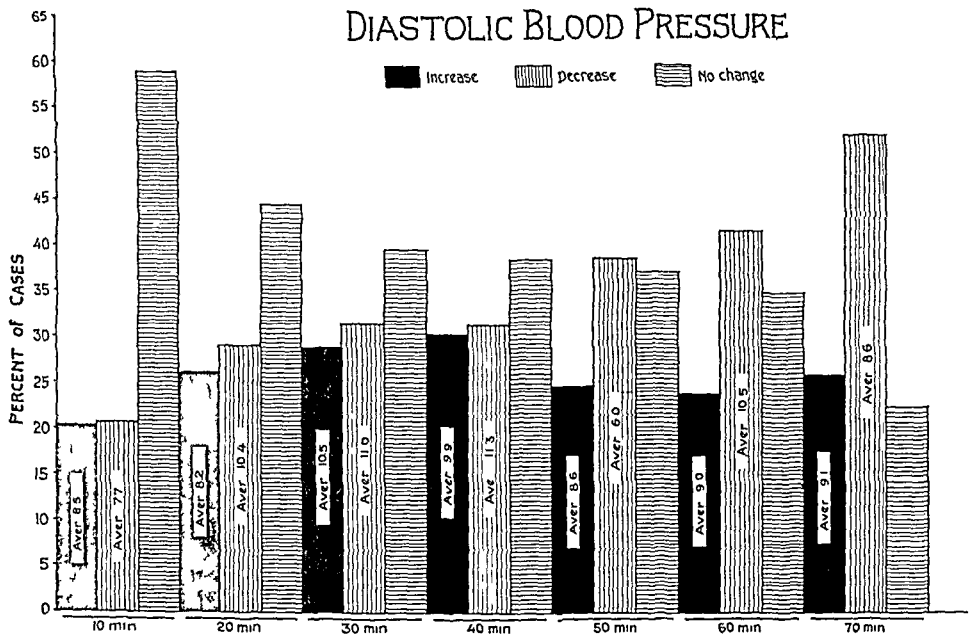


CHART III—The diastolic blood pressure is little affected early in the anesthetic as is shown by the very large percentage of cases which show no changes. This percentage decreases however so that at seventy minutes those cases showing a decrease are the largest number of cases. The figures on the blocks show the average increase or decrease in the diastolic blood pressure in millimetres of mercury.

analgesia, and the average duration of the effect of the drug is longer than was noted with novocaine crystals. It has been very unusual for analgesia to disappear in less than two hours, and in many instances operative procedures continued for two and a half hours without supplementary anaesthesia. The average length of time required for operations was forty-eight minutes. Satisfactory analgesia is always anticipated for one and a half hours, and in only a few instances has there been a shorter duration. In nine instances, operative procedures required longer than two and a half hours, inhalation anaesthesia was necessary as a supplement in three of these. In six cases, analgesia was present for less than one and a half hours and inhalation anaesthesia was necessary. The usual note on the chart indicates, however, that "gas was used while closing the incision." The higher the

been used routinely. In one instance 6 cubic centimetres were used, a second injection of the full dose having been made. In patients with a normal blood pressure, 50 milligrams of ephedrine was the usual dose and was given subcutaneously about five minutes prior to injection of the spinal analgesic solution. The dose of 100 milligrams of ephedrine was unusual and was given to "hypotensive" patients in whom "high" analgesia was necessary. Adrenalin has not been used in this series. In cases in which analgesia below the iliac crests was established, no ephedrine was used. In most of the patients a slight rise in the blood pressure was noted early, the blood pressure returning to normal or slightly below, as the operation progressed and the ephedrine effect became less. (Chart II) This drop below normal does

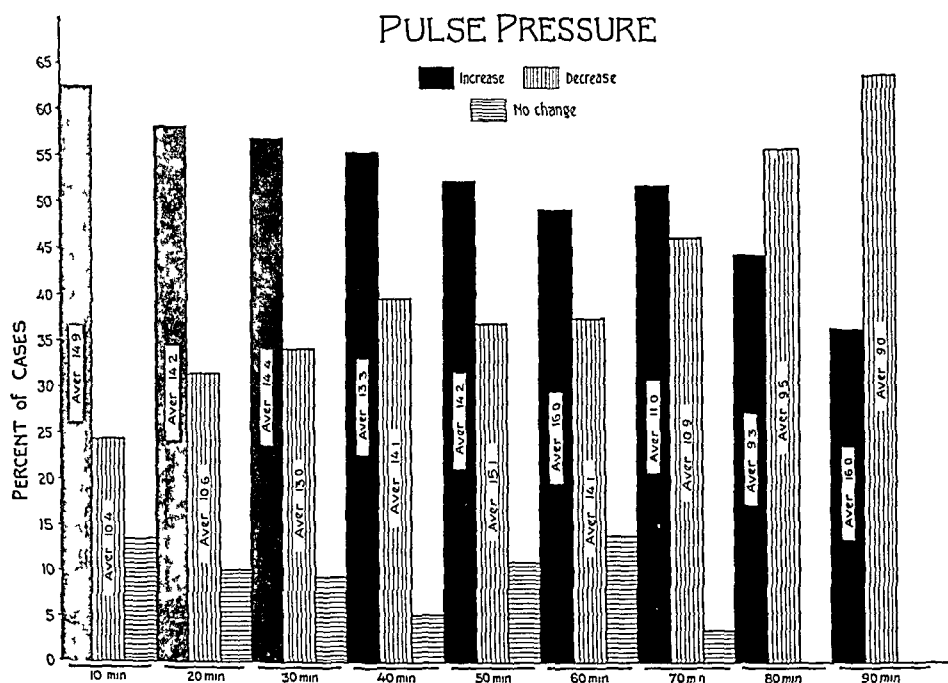


CHART V—The pulse pressure is increased at the beginning of the anæsthetic but consistently decreases as the anæsthetic and operation progress. The average increase or decrease of the pulse pressure is shown by the figures on the blocks.

not continue unless operative shock has been marked, for with the cessation of analgesia vasomotor equilibrium is quickly reestablished. Unless prevented, the blood pressure may drop to a sufficient degree to be alarming. This has formerly been a most frequent complication. It did not occur in this series, however, except in two cases in which the cause was plainly an unusual loss of blood. In one patient undergoing cæsarean section, a 46 millimetres of mercury decrease in the systolic blood pressure occurred fifty minutes after spinal injection, but during this time considerable bleeding had occurred. One patient became markedly exsanguinated from loss of blood from both uterine arteries during the course of a hysterectomy. The analgesia could hardly be blamed for the shock which occurred in this case.

The possibility of headache occurring post-operatively led the author to observe a routine of prophylaxis. Twenty-two gauge Pitkin needles were used routinely and especial care was taken not to allow the patient to make the slightest movement while the needle was *in situ*. Leakage from a large needle puncture or a rent in the dura, made by the patient's movement while the needle is in place, is the most common cause of post-spinal-puncture headache. A second type is due to blood, irritant solutions, or actual infection in the spinal fluid. Following operation, the bed was placed in the Trendelenburg position for twelve hours unless contra-indicated by other conditions, such as peritonitis. In this series no patient developed headache sufficiently severe to require special treatment. None complained of this symptom and only a few indicated its presence upon being questioned. Morphine was given routinely for post-operative pain, and undoubtedly this prevented many from complaining of a mild headache.

Vomiting has not been very frequent. Oxygen inhalations gave almost instant relief to those cases which exhibited some nausea during the period of analgesia. In all, 5 per cent of the cases in this series exhibited some degree of nausea and vomiting during the analgesic period. In no case was post-operative vomiting severe.

There has been no example of ocular palsy, motor paralysis, or sphincteric incontinence. There has been no fatality which could be directly attributed to spinal analgesia.

#### SUMMARY

Three hundred and fifty-seven cases of spinal analgesia induced with spinocain are reported. Twelve failures occurred. Of these, eight obtained satisfactory analgesia after a second sub-arachnoid injection of spinocain. The remaining four received no second injection and operation was performed under inhalation anæsthesia. No deaths occurred which could in any way be directly attributed to the spinal analgesia. The length of the analgesia period was definitely more prolonged than when crystalline novocaine dissolved in spinal fluid was used. Satisfactory analgesia for one and one-half hours was obtained in nearly every case. The analgesia period was shorter when the level of analgesia was high, as for upper abdominal operations. There were two cases which showed an alarming fall in blood pressure. In both instances, however, a severe hæmorrhage had preceded the drop in blood pressure. Ephedrine was given routinely, and was apparently responsible for preventing the drop in blood pressure usually seen following the induction of spinal analgesia. Post-operative urinary retention which required repeated catheterization was not encountered in this series. Severe post-operative headaches did not occur. Nausea or vomiting occurred in 5 per cent of the cases of this series. When this complication occurred, relief could be obtained by the administration of oxygen.

An analysis of the variations of blood pressure, pulse, and pulse pressure in the cases of this series is presented. This analysis was obtained from a

- <sup>1</sup> Stout, R B Spinal Anæsthesia, Volume Control Technic Am J Surg, vol vii, p 57, 1929  
*Idem* Spinal Anæsthesia, Volume Control Technic Wisc M J, vol xxviii, p 156, 1929  
*Idem* Spinal Anæsthesia, Blood Pressure Control Wisc M J, vol xxviii, p 261, 1929  
Stout, R B, and Ewell, G H Spinal Anæsthesia, with Remarks on Volume Control Technic Wisc M J, vol xxviii, p 113, 1929
- <sup>18</sup> Barker, A E Clinical Experience with Spinal Analgesia in 100 Cases Brit M J, vol i, p 665, 1907
- <sup>19</sup> Hepburn, W G Stovaine Spinal Analgesia Am J Surg, vol xxxiv, p 87, 1920 (Anes supplem)
- <sup>20</sup> Sise, L F Spinal Anæsthesia for Upper and Lower Abdominal Operations New Eng J M, vol cxix, p 59, 1928  
*Idem* Spinal Anæsthesia for Abdominal Operations N Y State Jr, vol xlv, p 1182, 1929  
*Idem* Fatalities and Their Prevention New Eng J Med, vol cc, p 1071, 1929  
*Idem* Lumbar Puncture Technic Am J Surg, vol v, p 577, 1928  
Sise, L F, and Woodbridge, P D Choice of Anæsthesia M J and Rec, vol cxvii, p 575, 1930
- <sup>21</sup> Garside, Earl Spinal Anæsthesia N O M and S Jr, vol lxxvii, p 453, 1930  
*Idem* Some Observations on Spinal Analgesia Med Jr and Rec, vol cxvii, p 563, 1930

to its complete success, and one should use it only after repeated observations and then only when one experienced in its use can direct him for a time

*Age and Sex of the Patients*—Table I gives the ages of the patients in decades and the ratio of males to females in this series

The number of patients in the second, third, fourth, fifth and sixth decades were about equally divided. There were none under ten years of age. We have avoided giving it to patients under ten years, but do not believe youth to be a serious contra-indication. Cooperation is lacking in the very young, and that is a serious handicap to the surgeon. Twenty-three, or about 10 per cent, were over sixty years of age. We have not considered advanced age as a contra-indication unless the systolic blood-pressure was extremely high (240) and the accompanying diastolic pressure comparatively low, or

AGES

DECADE	NUMBER OF CASES
1 - 10 years	0
10 - 20 years	43
20 - 30 years	37
30 - 40 years	45
40 - 50 years	40
50 - 60 years	32
60 - 70 years	19
70 - 80 years	4

Males 137; Females 83. =

220 = total

TABLE I—Ages by decades and ratio of males to females

unless the patient had a decompensated heart. Extreme hypotension (below 95 systolic), especially in adults, has been considered a contra-indication.

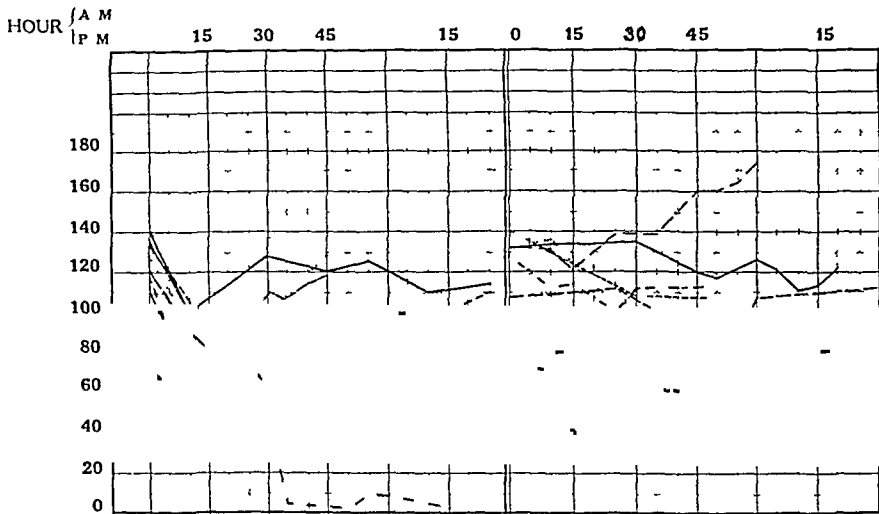
We have tried to limit the use of spinal anaesthesia in this series, as far as possible, to patients belonging to the good risk group, regardless of age, not wishing to discredit it by a high mortality rate in patients in whom it was used where the deaths were not definitely due to the anaesthetic.

The operations in this series are indicated in Table II.

It will be noted that there were no operations above the diaphragm. It is our opinion that operations above the diaphragm contra-indicate the use of spinal anaesthesia, the danger being paralysis of the voluntary muscles of respiration, and, when the anaesthetic reaches a little higher level (fourth cervical), paralysis of the phrenic nerve and, through it the diaphragm.

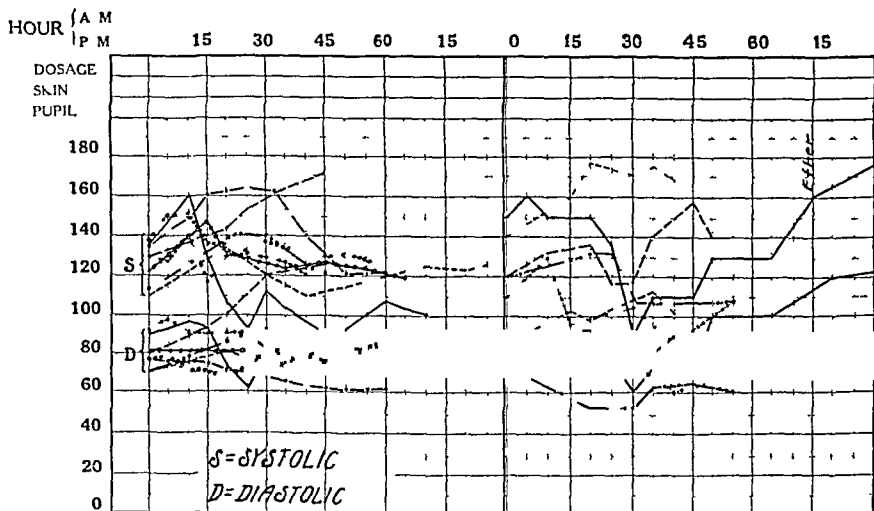
*Blood-pressure Effects*—By far the most interesting point in spinal anaesthesia is its effect on blood-pressure. The cause of the fall in pressure is unquestionably due to the paralysis of the white rami emerging from the anterior horn of the spinal cord. This paralysis results in a loss of vasomotor

crystals dissolved in spinal fluid The first amputation was above the ankle, the second just below the knee, and the third above the knee The behavior is seen to be practically the same during the three operations



GRAPH I—On the left side are a group of blood pressures which behave more or less similarly in that there is a moderate initial fall followed by a gradual rise of both the systolic and diastolic pressure (The line indicating the systolic pressure matches the line indicating its associated diastolic pressure in each case) On the right side is a group showing a more gradual fall followed by a gradual rise

We have observed that there are four types of blood-pressure behavior under spinal anaesthesia Graph IV illustrates the types and the percentages of each type



GRAPH II—The left side shows an initial rise in blood pressure in each patient instead of a fall This is probably due to the action of ephedrin The right side of the graph shows a few irregular types of blood pressure

In 70 per cent of the patients there was a slight rise of pressure after the ephedrin injection followed by a moderate fall, and then a gradual rise to the pre-injection level In 12 per cent there was a precipitous drop followed by a slow rise In 10 per cent there was a moderate rise, but no secondary fall

below the pre-injection level. In 8 per cent there was no marked change in blood-pressure during the entire operation. The time required for the blood-pressure to return to the pre-operative level in those cases in which there was a fall varied from forty-five minutes to twenty-four hours. It came back most slowly in the hypertension cases. The average time to the lowest blood-pressure was 30.6 minutes. The greatest decrease in systolic pressure was 166 points, and in diastolic pressure 70 points. The greatest increase in systolic pressure was 70 points, and in diastolic pressure 52 points. The average decrease in those in whom there was a fall was systolic 34 points and diastolic 22 points. The average increase in those in whom there was a rise was systolic 28.3 points and diastolic 21.3 points.

A study of the behavior of the *pulse-pressure* is also very interesting. It was determined at the time the blood-pressure was the highest and compared with that determined when the blood-pressure was the lowest with the following results. In 62 per cent of the series there was a decrease in pulse-pressure for an average of 23 points. In 30 per cent of the series there was an increase in pulse-pressure for an average of 12.5 points. In 8 per cent there was no change in pulse-pressure. These results are indicated graphically at the bottom of Graph IV. This record, we believe, is significant in that it shows that spinal anaesthesia tends to reduce pulse-pressure, and hence to stabilize circulation.

#### PULSE

Increased  20%

Constant  30%

Decreased  50%

Constant & decreased  80%

#### GRAPHIC INDICATION OF CHANGE IN PULSE RATE FROM BEGINNING TO END OF OPERATION

GRAPH V—Note the tendency of the pulse rate to decrease under spinal anaesthesia, indicating stabilization of the circulation.

Graph V indicates the change in pulse rate in the cases of this series.

In 50 per cent it decreased, in 20 per cent it increased, and in 30 per cent it remained constant. If the pulse rate in spinal anaesthesia is constant or decreased in 80 per cent of the cases, the frequently appearing statement that its effects are those of shock is not wholly true.

*Indications and Contra-indications*—We believe that spinal anaesthesia is indicated in (1) Intestinal obstruction (2) Surgery below the diaphragm on diabetics and patients with pulmonary affections or with kidney pathology. Spinal anaesthesia carries out Crile's anoci-association idea completely. In addition to these special indications we believe that spinal anaesthesia is the



The advantages to the surgeon are (1) complete relaxation of the abdominal muscles. This seems to us to be of extreme importance. Such relaxation allows for an easy and complete exploration of the abdominal cavity and for an easy closure of the abdominal wound. (2) There is less disturbance during the operation by the patient's attempts to vomit or strain. Although the patient may attempt to vomit, the abdominal viscera do not bulge into the wound because of the complete relaxation of the abdominal muscles.

The principal disadvantage is the shortness of the anæsthesia, making it at times necessary to use a supplemental anæsthetic such as gas or local infiltration. In our series of 220 cases, 28 (12 per cent) required supplemental anæsthesia as shown in Tables III and IV.

In three of these cases supplemental anæsthesia would not have been neces-

OPERATION	AMT. OF ANÆSTHESIA	DURATION	SUPPLEMENTAL ANÆSTHESIA
Herniotomy	100 mg -2 cc	1 hour	Novocaine infiltration of skin
Hysterectomy	150 mg -2 cc	1- hour	Gas
Appendectomy	150 mg -2 cc B	55 minutes	Airform for closing
Appendectomy	150 mg -2 cc B	No anesthesia	Spinal repeated
	150 mg -2cc B	1st * 2nd o k	
Bilateral herniotomy	150 mg -2 cc	2- hours	Local infiltration
Bilateral herniotomy	200 mg -2½ cc	1½ hours	Local infiltration
Exploration of common duct	200 mg -3 cc B	1½ hours	Gas for closing
Appendectomy	150 mg -2 cc	1½ hours	Novocaine infiltration of skin
Cholecystectomy	150 mg -3 cc	1 hour	Ethylene and ether
Hemorrhoidectomy	100 mg -1 cc	20 minutes	Nitrous oxide
Gonadectomy	150 mg -2 cc	25 minutes	Ethylene
Appendectomy	100 mg -2 cc	¾ hour	Ethylene
Appendectomy	150 mg -2 cc	1½ hour	Novocaine infiltration to close
Appendectomy	150 mg -2 cc	1 hour, 20 min	Ethylene
Appendectomy	100 mg -2 cc	1 hour	Ethylene
Cholecystectomy	200 mg -3 cc B	1½ hours	Ethylene
Herniotomy	150 mg -2 cc B	1 hour	Ethylene
Herniotomy	150 mg -2 cc	1 hour	Ethylene
Herniotomy (bilateral)	150 mg -2 cc	1½ hours	Ethylene
Appendectomy	150 mg -2 cc	1½ hours	Ethylene
Cholecystectomy	200 mg -3 cc B	¾ hour	Ethylene
Repair of laceration of leg	50mg -1 cc	1 hour, 10 min	Novocaine infiltration
Cholecystectomy	200 mg -3 cc	1½ hours	Ether

\* In one case of Novocaine crystals there was no anesthesia, so the injection was repeated with perfect results.

TABLE IV—Cases in which spinal anæsthesia was supplemented by other anesthesia

sary had we waited a few minutes longer before starting the operation. (See Table III.) These were cases in which nupercaine was used and the operation was started before its effect was complete. This solution requires a longer time to produce anæsthesia than novocaine, and in these cases a local injection was made for the initial incision. Two of the twelve cases in which spinocaine was used required a supplemental anæsthetic, and twenty-three of the 204 cases in which novocaine crystals were used required supplemental anæsthesia for closure. (See Table IV.)

*Complications*—Careful attention has been given to complications and post-operative developments in this series and the percentages are given in Table V.

Headache has frequently been mentioned in the literature as a post-operative development in spinal anæsthesia. The origin of it still seems to be

ranged from 112 to 38, and his diastolic from 80 to 0. His pulse rate was 140 to imperceptible. He became cyanotic and complained of air-hunger. The table was lowered in extreme Trendelenburg and pure oxygen was administered. An ampoule of coramine was given hypodermically and 1000 cubic centimetres of normal saline intravenously. No ephedrine or adrenalin was used for the drop in blood-pressure. The cyanosis lasted about ten minutes. This was the most extreme drop of the entire series, in fact, it was the only case in which the systolic pressure went below 50 millimetres of mercury. He died of bronchopneumonia on the ninth post-operative day.

CASE IV was a male, sixty-five years of age, on whom about half the stomach was resected for carcinoma. He also had tertiary syphilis and generalized arteriosclerosis. He was given 175 milligrams of novocaine crystals dissolved in 3 cubic centimetres of spinal fluid with barbotage. His systolic blood-pressure ranged from 98 to 78, and his diastolic from 74 to 54. He died on the second post-operative day of bronchopneumonia.

CASE V was a male, forty-nine years of age, on whom a herniotomy for strangulated hernia was performed. The patient was moribund, having had the strangulation for five days before entering the hospital. He was given 200 milligrams of novocaine crystals dissolved in 2 cubic centimetres of spinal fluid. His systolic blood-pressure ranged from 116 to 50, and his diastolic from 72 to 20. His pulse rate was extremely rapid all through the operation. No attempt was made to resect the bowel but the gangrenous loop was drawn out through a separate, higher incision and left to be opened at a later time. He died five hours after the operation from effects of toxæmia.

CASE VI was a male, sixty-six years of age, who developed gas gangrene in a burn on his leg. An amputation was performed. He was given 150 milligrams of novocaine crystals dissolved in 2 cubic centimetres of spinal fluid. His systolic blood-pressure ranged from 130 to 122, and his diastolic from 90 to 74. His pulse rate was 120 to 130. He died on the eighth post-operative day following extension of process into the muscles of the abdomen.

In all these cases the anæsthesia was satisfactory, and, as has been said above, in none could the death be attributed to the anæsthetic.

*Facts Concerning Skin Temperatures of Legs and Feet During Spinal Anæsthesia*—In order to determine the effect of spinal anæsthesia on the temperature of skin of the feet and legs, eleven cases were studied. These were patients with no circulatory derangement. The skin temperature over the instep of the right foot was taken before the spinal injection and again after anæsthesia developed. Table VI shows the results of these tests.

The temperature was elevated some in all cases following the spinal injection. Thinking this test would be of value to determine the advisability of sympathetic gangliectomy in cases of Raynaud's and Burger's diseases, it was used on one case of Raynaud's and the result is shown in Graph VI.

The skin temperatures of the feet rose 6° and 4° after the injection. To test the reliability, the typhoid vaccine test was applied to the same patient and the same result was obtained. This patient was operated upon with excellent results.

#### REPORT OF QUESTIONNAIRE

In 1927, a questionnaire was sent out by Dr. Edwin Stanton, of Schenectady, New York, to several hundred American surgeons with the object of

determining the anæsthetic most frequently used in good-risk and poor-risk cases and also to determine the extent to which spinal anæsthesia was being used at that time. There were 419 out of 622 surgeons (66 per cent) who stated definitely that they did *not* use spinal anæsthesia. There were 203 (34 per cent) who stated that they were using it in some types of cases

Answers to Questions 1 & 2	GOOD RISK CASES						POOR RISK CASES					
	Ether	N2O +O	Ethylene	Local	Spinal	Others	Ether	N2O +O	Ethylene	Local	Spinal	Others
ATLANTA	1	1 2+	3	0	4 2+		0	2+	1	5	4 2+	
BAITIMORE	5	1 5+	1	0	3	1 Avertin 1 " + E	0	1 2+	5	3	4 1+	
BOSTON	12	1 4+	1	0	9 2+		0	2-	2	6	13- 2+	
CHICAGO	9	9+ 12+	3	0	5		2 1+	4+ 4+	7 4+	8	10	
CLEVELAND	3	4 6+	0	0	5		2	6 1+	0	2	5	
DALLAS	1	0	1	0	2		0	0	0	0	4	
DENVER	11	1+	3	0	3 1+		3	2	2	4	5 2+	
DETROIT	8	1	2	0	14 2+		0	2	2	6 1+	13 2+	
KANSAS CITY	7 2+	1 2+	0	0	2		1	2 4+	1	3	2 1+	
LOS ANGELES	6	1 7+	3 2+	0	8 1+		3	3+	1 1+	7	11 5+	
MILWAUKEE	1	0	1	0	3		0	0	0	4	1	
NEW ORLEANS	2 1+	0	2 2+	0	0		0	0	2	1+ 2+	3	
NEW YORK	6	5+	2 2+	0	7 3+		2	0	0	8	13 1+	
OMAHA	1	1+	0	0	7 1+		1	0	0	1+	8	
PHILADELPHIA	2	1	0	0	4		0	1	1	2	3	
PITTSBURGH	2	1+	0	0	3		1	0	0	2	3	
PORTLAND	7	3+	3	0	2		0	4+	3	2 2+	4 1+	
SAN FRANCISCO	2	1 4+	0	0	9 6+		0	6+	0	4	12	
SEATTLE	5	1+	0	0	2		2	0	1+	3	2 2+	
ST LOUIS	5 1+	1 3+	5	1	3		0	2 3+	0	8	6	
Total	96 4+	13 54+	30 18+	1	95 19+		17 1+	18 29+	27 6+	77 6+	126 23+	
Percentage	30.3	20.3	14.5	0.3	34.5		5.4	14.2	10.0	25.1	45.1	

TABLE VII—On the left is a tabulation of the replies to question No. 1 "What anæsthetic do you use as a rule in laparotomies in the average run of good risk cases?" On the right are tabulated the replies to question No. 2 "What anæsthetic do you use in laparotomies comprising the poor risk group?" The plus sign after the figure indicates that some additional anæsthetic is used in certain cases

Those who were using it were, for the most part, using it in prostatectomies, amputations of the lower extremities, pelvic cases, and in diabetics. Twenty-one of them stated they reserved it for "poor-risk" cases.

Since then, spinal has become more frequently used and articles on the subject have appeared with increasing frequency in the literature. Thinking it would be of interest to determine the extent of the swing of the pendulum

Nine of 18 answering from Baltimore do not use spinal. This is the lowest percentage of all the cities. Seven of the 18 use avertin in a certain percentage of cases. Richard Te Linde states that 3 deaths in 15 spinal anæsthesias in 1929 caused the surgeons in Baltimore to look upon it with disfavor, and he also states that, except for the Brady Urological Institute, not much spinal is used at Johns Hopkins. Other Baltimore surgeons, including Shipley, Toulson, and Blake, do use it, some of them being very enthusiastic over it.

In Atlanta, Georgia, most of the surgeons answering the questionnaire use it to some extent. Dr. George W. Fuller uses it in practically all surgery below the diaphragm in both private and service cases. He states that some of the hospitals at Atlanta are using it in about three-fourths of the laparotomies.

In Boston, a large majority use spinal anæsthesia. Several volunteered the statement that novocaine crystals are being used almost to the exclusion of other preparations, such as Pitkin's solution, *etc*. Dr. A. R. Kingston uses it below the diaphragm in nearly 90 per cent. of his cases. He is one of several throughout the United States who state that Cæsarian section is a contra-indication to spinal anæsthesia. He states that he has, however, done Cæsarian operations under spinal without the slightest trouble, and is of the opinion that if it is used at all it should be used only in small dosage. Dr. J. S. White, of the Massachusetts General Hospital, states that because the incidence of pulmonary complications is as great under spinal as under ether, he is using it only in amputations of the leg or in perineal operations or where a low spinal can be used.

The Chicago surgeons, as a whole, are rather conservative in the use of spinal anæsthesia. Jonnesco's first case, many years ago, at the Cook County Hospital demonstration, died, and as a result spinal anæsthesia has gained favor slowly. Dr. James T. Case states that the popularity is gradually increasing now, however. He has used it in 1,700 patients, most of whom were gynecological cases. Ethylene, in both good- and poor-risk cases, is being used more in Chicago than in any other city of the country. Doctor Culbertsen, of Chicago, thinks that in the more difficult abdominal cases, with adhesions, *etc*, nothing gives the excellent intestinal relaxation that is present with spinal anæsthesia.

Few of the Cleveland surgeons use spinal as the anæsthetic of choice. Professor Cutler, of the Western Reserve University, employs it where the renal function is poor and in diabetics. He also uses it in prostatectomies and amputations of the leg. William Lower, of the Cleveland Clinic, uses it in all his urological cases unless there is some contra-indication.

Detroit surgeons are more enthusiastic concerning spinal than surgeons of any other large city, with the possible exception of New York and San Francisco. Clark D. Brooks has used it in 4,000 cases and uses novocaine crystals only.

In Philadelphia, the men doing a large volume of surgery are generally enthusiastic concerning spinal. Dr. Wayne Babcock, one of the pioneers in

(5) Urologists, as a group, seem most enthusiastic over spinal anæsthesia  
 (6) Intestinal obstruction was the condition most frequently mentioned in which spinal was the anæsthetic of choice

(7) There were 275 of the 330 surgeons who stated that spinal anæsthesia is increasing in popularity in their section of the country, and but 15 state that it is decreasing

(8) There were 40 who stated that they had observed no change in the number of surgeons using this type of anæsthesia

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3—20 per cent of the first series and 16 per cent of the second series had disturbing symptoms directly due to the spinal anæsthesia while on the operating table. The symptoms varied from slight shock with slight mental discomfort to severe shock, nausea and vomiting, and extreme mental disturbance and discomfort. This occurred with the patient's head both level and lowered and with manometer readings of spinal fluid pressure taken and the injection made at a uniform pressure—10 millimetres of mercury obtained by the amount of spinal fluid withdrawn. An anæsthetist was needed just as much with spinal anæsthesia as with general anæsthesia.

4—In 10 per cent of the first series and in 7 per cent of the second series the spinal anæsthesia failed completely or had to be supplemented with general anæsthesia.

5—8 per cent of the first series and 5 per cent of the second had severe headaches for the first few days following operation with extreme discomfort.

6—Although every method which has been suggested, including the use of spinocaine, was used, no uniformity of level or duration of analgesia was ever obtained. One patient who received 170 milligrams dissolved in 20 cubic centimetres of spinal fluid had complete analgesia of the entire body and died seven hours following the operation from shock and respiratory failure. The next patient receiving the identical amount in the same manner had to have general anæsthesia before the peritoneum could be opened, his analgesia lasting about fifteen minutes. Analgesia varied from none at all to one hour and forty-five minutes under identical technic. This variable factor could not be corrected.

Traumatic cases already in shock were never given a spinal anæsthesia after the first two cases due to the fact that it deepened their shock if an immediate operation had to be done or caused it to recur if operation was postponed until it had subsided.

The conclusions that can be drawn from this series of cases are the following:

1 Spinal anæsthesia, 40 to 120 milligrams of novocaine, in the fourth lumbar vertebral space for lower extremity, rectal, perineal, and hernia operations is safe and satisfactory. The post-operative complications are as numerous as with general anæsthesia. There is also a certain percentage of failures.

2 Spinal anæsthesia, 120 to 170 milligrams of novocaine, dissolved in 2 to 20 cubic centimetres of spinal fluid and injected in a higher level for abdominal and chest operations is not safe. The post-operative complications are as numerous as in general anæsthesia. The shallow respiratory excursions would accentuate rather than lessen the possibility of post-operative pneumonia. The only post-operative lung abscess which has occurred on the service was a gastric resection under spinal anæsthesia supplemented by nitrous oxide for the last half hour of the operation. Those patients who go into shock with resultant lowered tissue resistance are more susceptible to infection. The technical danger of injuring the cord at a higher level is always present.

# SPINAL ANÆSTHESIA WITH NUPERCAINE AND PROCAINE

## A COMPARATIVE STUDY

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ALTHOUGH we have been using procaine spinal anæsthesia extensively and successfully in urologic surgery for more than fifteen years, we have recently been trying nupercaine following a preliminary report of its use by Keyes and McLellan <sup>†</sup>

We were impressed with the reports of the German investigators concerning this compound, derived from quinolin, particularly in regard to the intensity of anæsthesia. It is to be noted, however, that not all the reports showed uniformly successful results, also where failures were recorded, faulty technic was generally blamed as the cause of failure.

Some have found that a 1-2000 solution for infiltration purposes, despite statements to the contrary, does not equal the anæsthetic activity of 0.5 per cent procaine. Suffice it to say, that, for infiltration purposes, in a limited series of cases, we have found 1 per cent procaine more satisfactory and have given up the use of nupercaine by this route.

Nupercaine has been used for spinal, caudal, paravertebral and infiltration anæsthesia, also for topical application to mucous membranes.

We have been impressed with the statement that the substance, prepared by Karl Miescher, is five times more toxic than cocaine and having ten times the activity of the latter drug. However, subsequent work on animals, together with its clinical use, would indicate that the margin of safety in its use, as prescribed, is much greater than the figures given.

With the maximum dose of cocaine fixed at 50 milligrams, the maximum dose for nupercaine would, therefore, be 10 milligrams. This latter dose is contained in 2 cubic centimetres of 0.5 per cent solution (used by us in ampoule form for spinal anæsthesia). This dose would also be contained in 10 cubic centimetres of 1-1000 solution and 20 cubic centimetres of 1-2000 solution.

It is to be noted that solutions in salt solution can be sterilized at 221 degrees F. for one half hour without impairing their activity. The sodium chloride must, however, contain no soda or sodium bicarbonate, and, when kept, should be contained in alkali-free glass. It has been recommended that five drops of dilute HCl be added to containers of solution of 1-1000 or 1-2000.

We have not seen the hyperæmic condition of the skin or possible skin necrosis said to have followed its use. It has been suggested that a few drops of adrenalin be added to the solution before injection to correct this effect.

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<sup>†</sup> Keyes, E. L., and McLellan, A. M. *Am. J. Surg.*, vol. 12, p. 1, July, 1930.

## ANALYSIS OF 50 CONSECUTIVE PROCAINE SPINAL ANÆSTHESIA CASES

1—Failures, total and partial—2 cases or 4 per cent

Insufficient duration anaesthesia—4 cases or 8 per cent

2—*Type of operation*

Kidney—9 cases, with no failures

Bladder—14 cases (with two imperfect anaesthesia)

Prostate—19 cases (with two imperfect anaesthesia)

External genitalia—8 cases (with two imperfect anaesthesia)

3—"Puncture" headache rarely occurred in any of our procaine cases (including a previous large series)

4—The induction-time was definite, more rapid, but anaesthesia of much shorter duration than with nupercaine

*Analysis of six imperfect procaine anaesthesia cases* Failures 1—Second-stage prostatectomy Procaine 120 milligrams After ten minutes, gas-oxygen anaesthesia was used Operation lasted thirty-five minutes

2—Cystotomy and fulguration of bladder carcinoma Procaine 240 milligrams Operation started five minutes after spinal injection After waiting twenty minutes, gas-oxygen anaesthesia was used to complete operation and obtain relaxation Blood pressure did not fall (120/60) Operating time, 55 minutes

Insufficient duration of anaesthesia (procaine) 1—Bilateral hydrocele and varicocele Procaine 120 milligrams Induction-time five minutes with good anaesthesia Operating time, thirty-five minutes Morphine sulphate grains  $\frac{1}{4}$  given after thirty minutes as sensation began to return No general anaesthesia used

2—Resection of carcinoma of prostate (radiotherm knife) Procaine 120 milligrams Induction-time, five minutes Operating time, sixty-four minutes Gas-oxygen anaesthesia used five minutes before completion of anaesthesia (Anaesthesia lasted fifty-five minutes Then blood pressure rose from 120 to 140 suddenly)

3—Bilateral epididymotomy Procaine 120 milligrams Induction-time, five minutes Blood pressure, 100/50 after five minutes, 135/90 after fifteen minutes, 120/70 after twenty-five minutes Operating time, sixty minutes Light gas-oxygen-ether was begun ten minutes after incision was made because patient was very uncomfortable and apprehensive Usual pre-operative medication of morphine sulphate grs  $\frac{1}{4}$  Scopolamine grs  $\frac{1}{200}$  had been given

4—Cystotomy and resection of bladder carcinoma Procaine 120 milligrams Induction-time, five minutes Operating time, seventy minutes Pain felt after thirty-five minutes Gas-oxygen given at end of forty minutes

*Analysis of nupercaine failures* Failures 1—External urethrotomy Waited twenty minutes Gas-oxygen used (Patient apprehensive)

2—Nephrectomy Waited ten minutes with no anaesthesia at the end of this time General anaesthesia used

3—Coffey ureteral transplantation Waited forty minutes General anaesthesia used

4—Hydrocele No anaesthesia after fifteen minutes Light gas-oxygen used

Partial failures (nupercaine) 1—Nephrectomy Waited only eight minutes Complained of pain Supplemented by light gas-oxygen which was stopped ten minutes before end of operation (Patient apprehensive)

2—Nephrotomy Waited twenty minutes Patient complained of pain during operation No supplementary anaesthesia given (Apprehensive) Second operation under 150 milligrams procaine (ureterotomy) with perfect anaesthesia

3—Ureterotomy Waited twenty minutes Light gas-oxygen given

4—Coffey ureteral transplantation Waited twenty-five minutes Light gas-oxygen used Some anaesthesia present after three hours Operation required two hours (Patient very apprehensive)



to exclude the motor fibres would appear to be impractical for major surgical operations

(14) The action of nupercaine is definitely more variable and uncertain in our hands

(15) We have not been disposed to try the method suggested of injecting a mixture of procaine and nupercaine

(16) Nausea or vomiting has been exceptional and there was no evidence of frank toxic reaction on the part of any patient in this series

(17) Continued investigation in spinal anæsthesia should now be carried on by the physiologist, pharmacologist and chemist working in conjunction with the clinician

easily, and cannot be tied securely, all of which desirable characteristics are present in the chromic gut

Figures 2 and 3 are X-ray films of a typical case in which this method of suture has been followed. All of these operations were done under the tourniquet and it is interesting to note that three of the seven cases presented the post-operative complication of loss of function of the nerves of the hand and fingers, which persisted over a period of about three weeks when

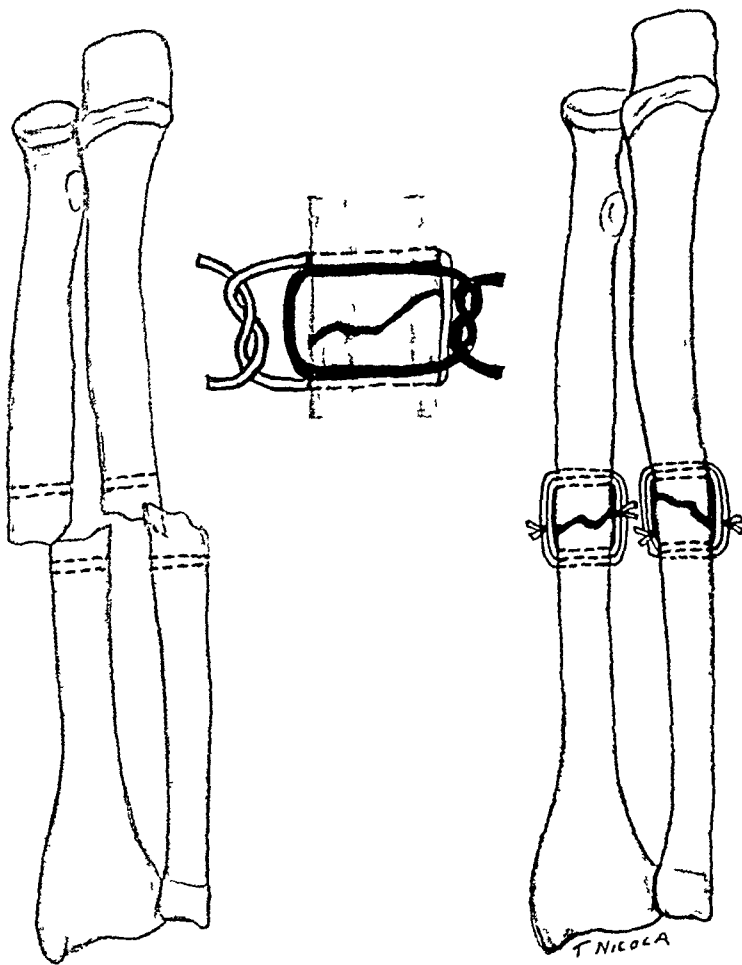


FIG. 1.—Method of insertion of the double suture

the sensory and motor power had returned almost completely. They were all immobilized in circular plaster-of-Paris bandages. These bandages were left on for five weeks. The bandages extended from the metacarpal phalangeal joints to the axilla, with the wrist in slight dorsal flexion, the forearm supinated, and the elbow at a right angle. Care was taken that the bandages were not tight, so that this lack of nerve function was due to the tourniquet and not to the plaster-of-Paris bandage, as the fingers were but slightly swollen and their color was good. In spite of this in these particular cases the bandages

the return of both motor and sensory function was complete. This return of function was an agreeable surprise to me as I felt that the operative procedure was inadequate. All of these patients have made complete recoveries, with two exceptions, the two most recently operated upon. They are joining up satisfactorily at the present time, though union has been delayed. There was an infection in one case and subsequently several sequestra were extruded, but the bony union and function were not impaired.

I have, on several occasions, as, for instance, in the patella or in a clavicle, used two sutures with the knots tied on the same side of the bone to obtain additional security. I feel that this is a desirable method of suture. This is obviously not the method that I am describing.

The reporter remarked that cases of hepatic-duct calculi are not uncommon. Intrahepatic calculi, especially of large size, are rather rare. Either may occur in the absence of calculous cholecystitis.

Frerichs<sup>1</sup> states that gall-stones in the interior of the liver and in branches of the hepatic duct are rare but quotes Morgagni who collected a series of observations from the works of Plater, Fallopius, Dodonoeus, Columbus, Paysch and others showing concretions which have been found in the interior of the liver. Most of these concretions were large, round stones and more rarely branched coral-like concretions which form casts in the ducts and are sometimes solid but at other times hollow. These concretions may give rise to inflammation, ulceration of the ducts also to hepatic abscesses and pyelephlebitis.

There are said to be many specimens of multiple intrahepatic calculi in the museums of London and Westminster Hospitals. Beer<sup>2</sup> dissected 250 livers of patients who had succumbed to gall-bladder disease and found six cases of definite intrahepatic stone formation, that is, in 2.5 per cent.

Thudichum<sup>3</sup> reported six cases of large branching intrahepatic calculi. Another case of intrahepatic calculus was reported from St. George's Hospital of a man who died with diabetes from a secondary pancreatitis.<sup>4</sup> Vachell and Stevens<sup>5</sup> reported a case in which there were 520 calculi within the liver substances and the ducts. The largest was one and three-quarters inches long.

Intrahepatic calculi are chiefly composed of bilirubin calcium, whereas stones found in the gall-bladder are usually cholesterol stones. Because of this difference in the consistency of the calculi and because of the fact that intrahepatic stones may occur independently of calculi in the gall-bladder, the etiology requires further discussion. Beer<sup>2</sup> states that intrahepatic stones are probably formed in the liver rather than having been formed originally in the gall-bladder because of the fact that the stones removed from the hepatic duct and liver differ in shape, color and character from those usually found in the gall-bladder. Moreover, as mentioned above in many cases reported of intrahepatic stone there have been no stones in the gall-bladder. Undoubtedly the intrahepatic calculi and the calculi found within the hepatic ducts must originate in the liver. In some cases of intrahepatic calculi, jaundice is present. In others, it is absent as in Draper's case. In Hawkes' case<sup>6</sup> there was slight jaundice. In this case the gall-bladder had been previously removed. The patient left the hospital two weeks after cholecystectomy but attacks of pain continued. The patient was subsequently operated upon. No calculi were found in the ducts but "upon passing the hand upward toward the dome of the liver on the right side, a large calculus was found embedded in the liver substance about four inches from the free border of the liver." Hawkes performed this operation in two stages, introducing sterile gauze at the first operation to form adhesions. At second operation, four days later, the liver substance was incised and the calculi "dug out with the index finger from an indurated mass of surrounding tissue." Three large calculi were removed. There was considerable hemorrhage which was checked by tamponade. In Doctor Owen's case the cautery was used for the liver incision and no worrisome hemorrhage occurred. Hawkes suggests the advisability of palpating the liver surface during operation in cases diagnosed as cholelithiasis where the findings in the region of the gall-bladder and ducts do not seem sufficient to account for the symptoms present. He further states that it "seems possible that liver abscesses of unknown etiology have arisen from such cause." Vachell and Stevens<sup>5</sup> reported a fatal case of intrahepatic calculus associated with multiple abscesses of the liver and subdiaphragmatic abscess. The gall-bladder in this case was normal in size and contained no calculi. Jaundice was not present until nineteen days before death. Chemical analysis of these calculi showed a predominance of calcium bilirubin. The culture from the abscesses of the liver showed *Bacillus coli* and whereas the patient had typhoid a number of years before, the typhoid bacillus was not found.

the following day 1,500 units of tetanus antitoxin were administered into the subcutaneous tissues of the anterior abdominal wall. On December 25 he developed a severe generalized urticarial reaction for which he received an injection of adrenalin. On December 28 he was awakened during the night with very severe pains in the neck, more severe on the right side, pains in both shoulders, hands, forearms and in the intrascapular areas. He could not move his fingers or wrists and both upper extremities were weak. His hands and forearms felt as though they were swollen. The pain, which continued until the end of the first week in January, was associated with numbness and tingling in the hands and forearms.

January 5 the following findings were noted. The power in the left upper extremity was normal, excepting for slight weakness of the hand grasp. There was marked weakness in the grip of the right hand, and about 70 per cent loss of power in the extensors of the wrist. He complained of very severe pain in the neck, shoulders, intrascapular areas and both arms. There was tenderness over the muscles of the right side of the neck, the axilla and over all the nerve trunks in arms and forearms. Extreme abduction of the arm caused severe pain. No objective impairment of sensation could be elicited, but subjectively there were numbness and tingling of the right hand and forearm. Tenderness, not as severe in character, was noted over the nerve trunks of the left arm. Power of both deltoids normal. There was definite weakness of the biceps and triceps muscles of the right arm. The left biceps and triceps muscles were normal. The bicipital and tricipital reflexes could not be obtained on the right side, but were normal on the left.

The above symptoms improved slowly. On January 9 he was able to resume light duty. By January 19 he had recovered sufficiently to return to active duty. Recent examination reveals that the power in both arms and hands is normal and equal. On lifting weights there is a moderate winging of both scapulæ. The patient states that he does not appear to have the same strength in his arms and hands as he had prior to the attack of neuritis.

The speaker remarked that cases of multiple neuritis following the prophylactic injection of tetanus antitoxin have been previously reported. The first report in the literature is by Thaon<sup>1</sup>. Approximately twenty cases have been reported. This manifestation of allergy is a comparatively rare one. Braunlich<sup>2</sup> cautions against the use of fresh tetanus antitoxin, stating that as a result of its use, serum reaction occurs more frequently and is more severe. Multiple neuritis may follow prophylactic injection of tetanus antitoxin or other sera. The prophylactic or therapeutic use of serum must be administered with the realization of this fact. None of the present indications for the administration of sera should be ignored because of the comparatively rare complication of neuritis. More careful testing for sensitization is advisable in the use of anti-sera to avoid this and all other unpleasant complications of serum therapy.

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<sup>2</sup> Braunlich, George. *Anaphylaxis Following the Injection of 1,500 Units of Tetanus Antitoxin*. *Iowa State Medical Journal*, No. 17, p. 450, December, 1927.

tion were continued and in addition 5 per cent glucose in normal salt solution was administered through the jejunostomy tube by the Murphy drip. The patient's condition did not change very much in twenty-four hours, so a Jutte tube was left in the stomach and every two hours the gastric contents were aspirated and introduced into the jejunum through the jejunostomy tube. This procedure benefited the patient symptomatically and produced a definite improvement in the degree of dehydration in twenty-four hours. Charcoal was placed in the stomach after the aspiration at various intervals, but no trace of it could be found in the jejunum until seventy-two hours after the operation. On the fourth day the temperature became normal, and on the fifth day fluids passed through the stomach readily. Oral feedings were started and gradually increased, intravenous injections of glucose and salt solution were discontinued on the sixth day, feeding through the jejunostomy tube was discontinued on the eighth day, and the jejunostomy tube was removed on the fourteenth day. Subsequently, the convalescence was uneventful. Since his discharge from the Hospital, the patient has gained twenty-two pounds in weight and is symptom-free.

The second case, a man, forty-one years of age, was admitted to the Presbyterian Hospital April 18, 1927, under the care of Doctor Pfeiffer. He had an eight-year history typical of duodenal ulcer and the X-ray was positive for this lesion. April 22, 1927, a laparotomy was performed, a duodenal ulcer was found, and a gastroenterostomy and appendectomy were performed. The patient's immediate post-operative reaction was satisfactory and he was able to take soft diet with no discomfort. On the eighth day symptoms of gastric retention developed with an elevation of the temperature of  $100\frac{1}{5}^{\circ}\text{F}$ . Gastric lavage was performed and glucose and saline were administered intravenously. Blood chemistry studies showed a more severe alkalosis than was found in the first patient. The  $\text{CO}_2$  was 85 volumes per cent, the blood chlorides were 208 and the blood urea nitrogen, 26 per cubic metres of blood. The patient's condition became progressively worse and the gastroenterostomy was explored on the twelfth day. Both the proximal and distal loops were greatly inflamed, the stoma was closed and the distal loop was collapsed beyond the area of inflammation. An enteroenterostomy was made between the two loops. Gastric lavage and intravenous medications were continued. There was slight improvement for twenty-four hours, but the patient's progress was not satisfactory. On the second day a jejunostomy was performed with a marked relief of symptoms in twenty-four hours. Forty-eight hours after the jejunostomy the patient's temperature fell to normal and at the end of four days fluids passed through the stomach into the jejunum. The diet was gradually increased until solid food was taken with no evidence of retention. Three weeks after the jejunostomy, when the patient had completely recovered from the gastric retention, an upper respiratory infection occurred which was complicated by multiple abscesses of the lung and empyema which was ultimately responsible for his death, two and one-half months after the original operation. The respiratory condition is mentioned briefly as before the onset of this complication, the inflammatory reaction of the loops of the gastroenterostomy had subsided and the patient was well on the road to recovery.

These cases are presented for two reasons. First, inflammation of the loops was the cause of gastric retention following gastroenterostomy, and secondly, the jejunostomy placed the inflamed area at rest, permitting the inflammation to subside and thereby relieving the obstruction.

difficulties of major operative interference, a jejunostomy was performed. The patient had relief from pain in eight days, the jejunostomy tube was left in place for six months and during that time no food was taken by mouth. Eight months after the operation the patient returned symptom-free, all evidence of the lesion had disappeared and the X-ray was negative.

DR DAMON B PREIFFER said that since the standardization of the technic of gastroenterostomy has been so well placed before the profession by many surgeons, notably Moynihan, we have become accustomed to think little of what was formerly called vicious circle. The physiologic gastroenterostomy makes it very much simpler for the contents of the stomach to enter the jejunum rather than go down to the proximal loop. These two cases show that there is a type of obstruction which is not a simple mechanical one but which is due to adynamic ileus. The speaker has seen a somewhat similar condition in the colon in which the bowel had lost its elasticity. One sees it most frequently in the late stages of ulcerative colitis. The physiologic block is not due to any actual obstruction but to the inflammatory ileus. He would hesitate very much to delay operation in cases showing marked gastric retention after gastroenterostomy, hoping it would disappear. It might disappear but the proper thing to do is to explore.

DR EDWARD T CROSSAN said that Doctor Bothe states that the gastroenterostomy was done in the usual manner. He would like to know whether the "usual manner" means that there were three layers of sutures posteriorly, or whether two layers were used. He would also like to know whether the opening in the transverse mesocolon was sutured close to the stoma. It would appear that if three layers of suture are used posteriorly, and in addition to this the rent in the mesocolon be sutured close to the stoma, there is sufficient irritation from the foreign bodies to cause an inflammatory reaction such as described in these cases. The speaker agrees with Doctor Pfeiffer that jejunostomy should clear up cases of inflammatory ileus.

DR GEORGE P MULLER remarked that operative interference was often unwisely postponed in the hope that obstructive symptoms would be relieved. This practice occasionally results in the neglect of a patient suffering from severe mechanical obstruction. The speaker, however, recalled one patient whom he had ordered prepared for re-operation when it was discovered that there was a marked alkalosis. Large quantities of hypertonic saline and glucose solution were given and in twenty-four hours the clinical picture had completely changed. Doctor Muller, therefore, advocates serious consideration of the chemical state of affairs and if treatment along these lines fails to give relief, operation should not be delayed. In certain cases infection from the stomach may be carried to the suture line and thus produce an inflammatory reaction in the stoma which will prevent it from functioning.

DR FREDERICK A BOTHE said that he used two rows of sutures and sutured the mesocolon about two and one-half inches from the anastomosis.

of pituitrin Doctor Frazier's experience with this dosage has been satisfactory and gave no cause for alarm

DR GEORGE P MULLER said he saw the publication of Doctor White's previous paper He had begun the use of avertin and during the winter had used it in forty-three cases, of which about half were goitre Forty were successful from the standpoint of anæsthesia Blood pressures usually fell for a short period but not nearly so much as occurred in spinal anæsthesia Nitrous oxide gas was used as a secondary anæsthesia and the patients required but little of it No patient showed any complication from the avertin

DR EDWARD W BEACH said that he had used avertin, not so much as the essayists, but had found it very satisfactory There is a drop in pulse pressure early in the anæsthesia The reaction is very quick Cyanosis has not given trouble although he always has a tank of CO<sub>2</sub> and oxygen present He varies the dosage according to the operation, in major abdominal work using the larger doses The advantage of nitrous oxide as the supplemental anæsthetic is that one maintains a high percentage of oxygen which is desirable as it maintains a higher metabolic rate In other words, one can conduct a section on a 50-50 instead of an 80-20 mixture Doctor Beach thinks avertin possibly impairs the action of the kidneys at first but only temporary It certainly is an approach toward the ideal, and the patients are all well pleased

DR CHARLES S WHITE, said that he believed the proper way to use avertin is to begin with a small dose, 60 milligrams for instance, and gradually increase it in various cases until the proper dosage is reached This will be 80-90 milligrams per kilo of body weight He did considerable laboratory work in connection with avertin, but did not go into the matter of dosage because this has already been well worked out by the Germans He believes avertin is a distinct advance in anæsthesia and is well worth trying For a long time he has been considering the anæsthetic from a surgeon's standpoint, in his opinion it is now time to give the patient due consideration

DR JOSEPH KREISELMAN, replying to questions, said that he was not prepared to make a comparison between amytal and avertin He had never used the former It is a little difficult to give a definite dosage In the beginning he used 100 milligrams almost routinely for abdominal surgery He would use 100 milligrams in a young healthy adult man now, perhaps in a young woman In an obese patient, say 160 pounds, he probably would use somewhere between 80 and 90 A recent patient who weighed about 170-180 pounds and had a blood sugar of 300 received what he estimated to be about 50-60 milligrams and there was practically no change in her blood sugar post-operatively He has never used it intravenously The speaker does not consider 80 milligrams enough for the average abdominal operation On occasions 100 milligrams is slightly exceeded The respiratory rate is decreased with the larger doses Cyanosis has not been observed in any case



there is an overflow of secretion so that it reaches the skin, it has passed over 10 to 15 centimetres of intestinal mucosa, and excoriation is reduced to a minimum. In several months of observation we have not seen leakage from the fistulas, thus raising the question of absorption of the acid by either the stomach or more probably the ileum mucosa. We hope to answer this question in the near future. The two-stage procedure enables the fistulous opening to become well healed before any appreciable amounts of acid secretions pass over it.

The animals used in such experiments do not require special care. At any time about 20 cubic centimetres of gastric juice can be obtained, the amount depending on the size of the pouch. The small amount of secretion of the loop of intestine returning to the pouch can be readily prevented, when pure

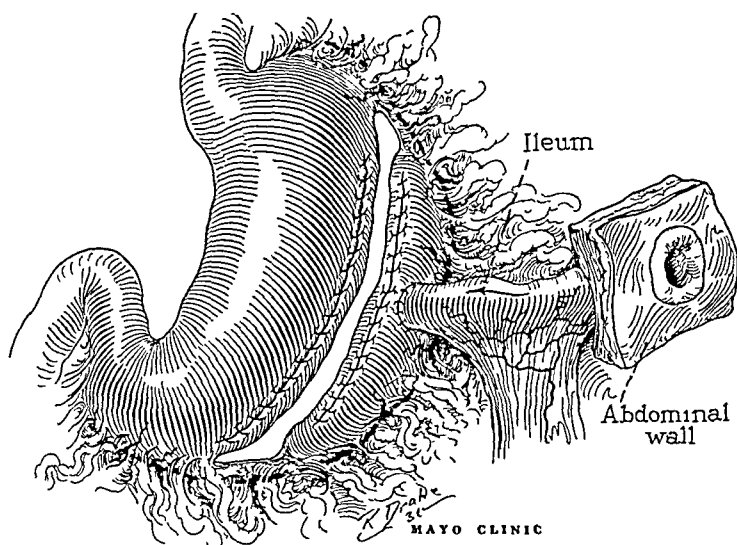


FIG 2—Second stage of fundus pouch

gastric juice is desired, by inserting a Pezzer mushroom catheter well within the pouch and exerting enough traction on it to impinge the mushroom against the contracted line of the gastro-ileal anastomosis. Acid values are in every way comparable to those obtained in dogs with a Pavlov pouch; excoriation and continuous care are eliminated and sufficient volume of secretion can be obtained for practically all experimental purposes.

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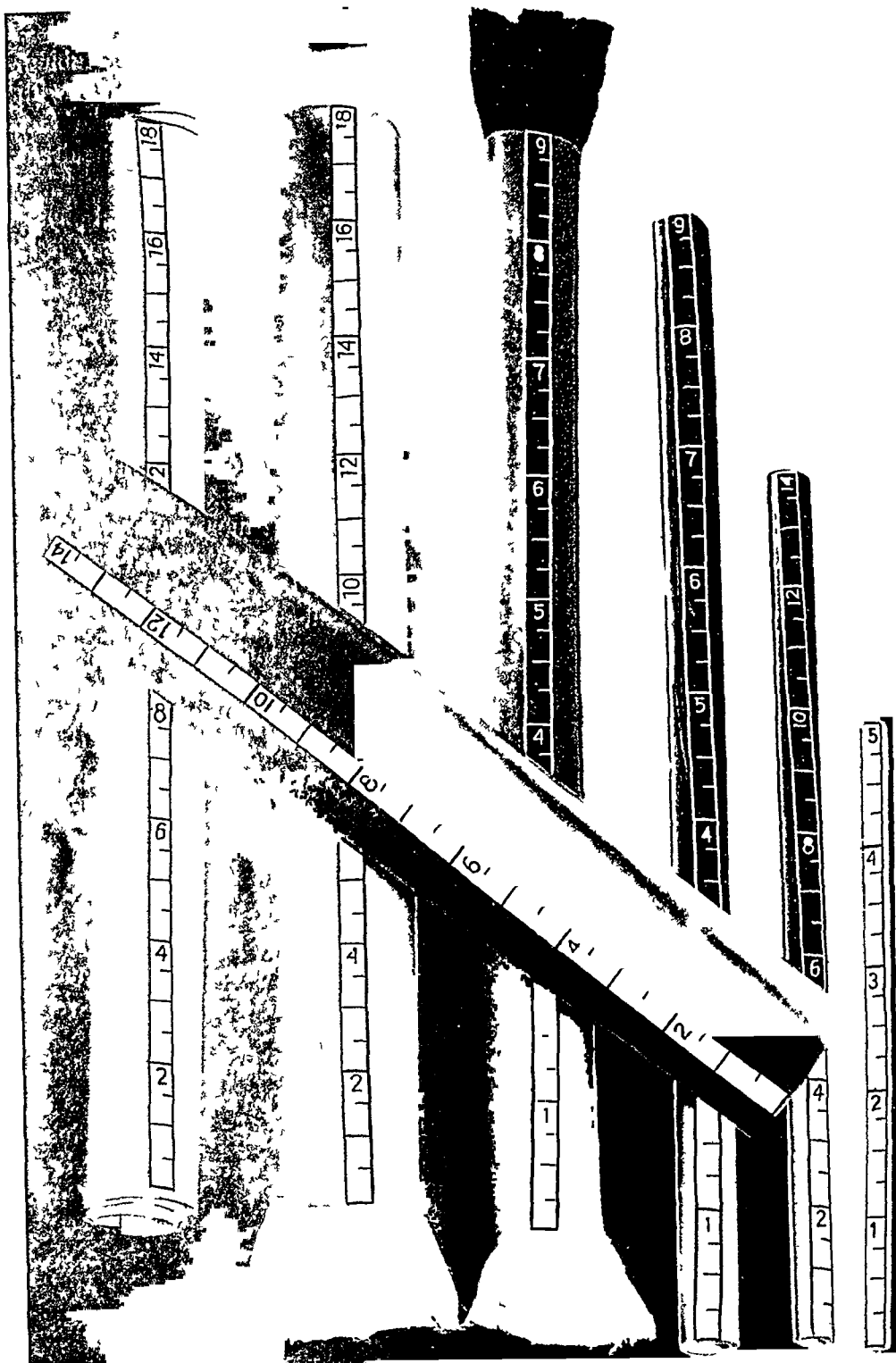


FIG 1—(1) Rubber tubes (various calibres) calibrated in centimetres and inches (2) Cigarette drains calibrated in centimetres and inches (3) Rubber dam calibrated in centimetres (4) Penrose tube calibrated in centimetres

## BRIEF COMMUNICATIONS

Fig 2 shows its modification, and might be termed a subcuticular type of Stewart suture. The suture is introduced by a straight cutting needle at point (A) on side of assistant to point (B), similar to the usual Stewart stitch, going to deeper layers of skin and subcutaneous tissues to obliterate any dead space

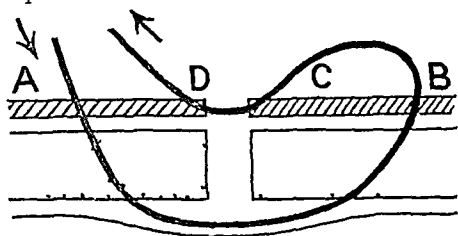


FIG 1

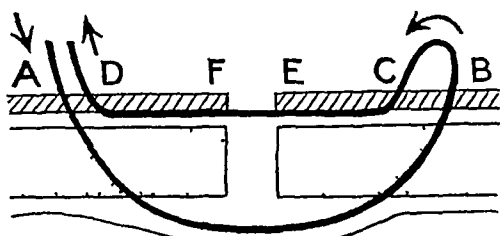


FIG 2

Instead of going to point (C) Fig 1, the needle is then directed to point (C) Fig 2, one-quarter of an inch medial to point (B) and allowed to pass directly under the skin and emerge at point (E)—edge of incision



FIG 3—Herniotomy wound  
Ninth day post operative upon re-  
moval of above type of suture. Note  
only three sutures used, hair line  
scar, absence of cross marks

Then the needle is passed subcuticularly from point (F) to (D), the latter emerging one-quarter of an inch medial to point (A)

The suture is then tied, giving a perfect hair-line wound approximation similar to a subcuticular suture

This suture can readily be removed by cutting either end and pulling out

The suture as used on clean cases at the Bellevue Hospital has proved very satisfactory. The suture is easily applied, gives an excellent hair-line approximation, avoids cross wound cutting and scarring, and is easily removed

VICTOR CARABBA, M D,  
New York, N Y

*From the Third Surgical Division, Bellevue Hospital, New York City*

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## BOOK REVIEWS

through every page of the monograph. This makes it really valuable. The early enthusiasm of numberless biologists and surgeons about Leriche's operation and all other procedures aiming at destroying the fibres of the sympathetic nerve, entering nerves, blood-vessels, glands, *etc*, is absent. A sober endeavor to restudy thoroughly the whole subject, beginning from its anatomical and physiological basis, without being swayed by enthusiasm or discouraged by poor results, makes Scalone's monograph most praiseworthy.

Scalone's monograph should be consulted by anyone intending to do surgery of the sympathetic system, because it relates the personal, unbiased experience of an intelligent, competent, hard-working surgeon and biologist who has devoted twenty years to the study of the subject.

ANGELO L. SORESI

UROLOGICAL ROENTGENOLOGY (Second edition revised) By HUGH A. YOUNG, M.D., AND CHARLES A. WATERS, M.D. 4 vo, cloth, pp 560. Paul B. Hoeber, New York, 1931.

The review of the first edition of this work appeared in the *ANNALS OF SURGERY*, vol. LXIX, No. 3, March, 1929. The remarks made then may be reiterated. A second printing of the volume necessitated at this time has given the authors an opportunity of incorporating the advances in urology made during the past two years and of revising and elaborating the previously written chapters. Thus, many new and interesting cases have been incorporated, gathered both from the literature and from recent cases in the Biady clinic.

Since the publication of the first edition, the subject of intravenous urography has been developed and a new chapter devoted to the details of its administration has been added. The discussion of the evaluation of these new methods is of definite value. A second chapter takes up the consideration of the more recent technic of arteriography and depicts graphically the delineation of the aorta and its abdominal branches in urological roentgenology. A few pages have also been added showing the clinic methods of keeping records. The new Young-Elvers phthaleinometer is also illustrated and its use described.

In all, sixty-four pages and seventy-four illustrations have been added to the original work. The general composition of the volume is most excellent and will prove of great value not only to the specialist, but to the general practitioner and surgeon as well.

JAMES T. PILCHER

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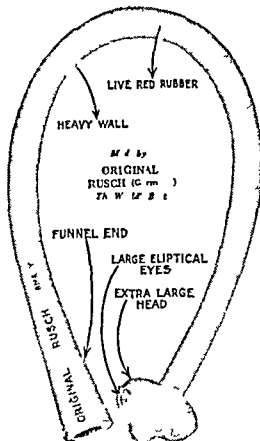
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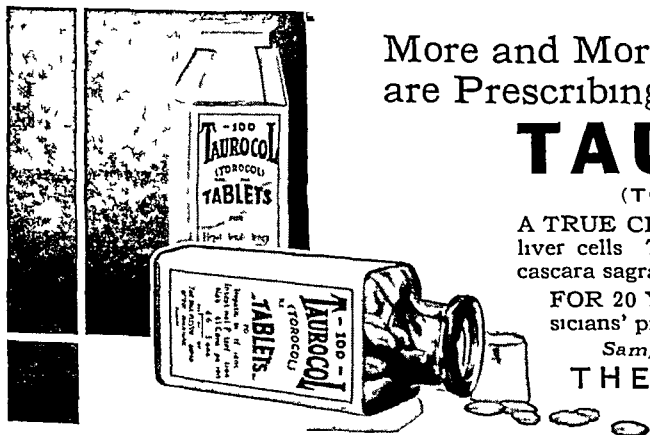
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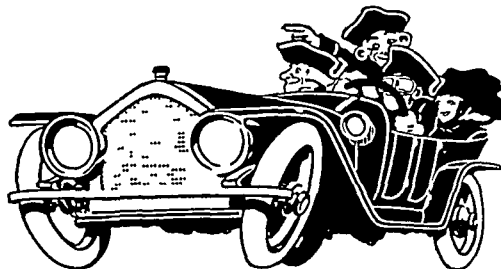
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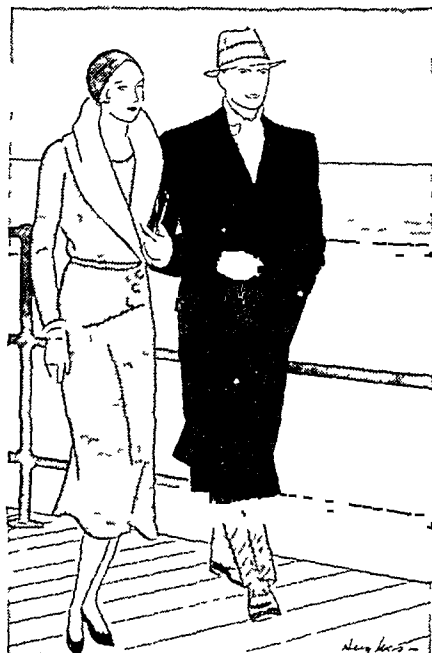


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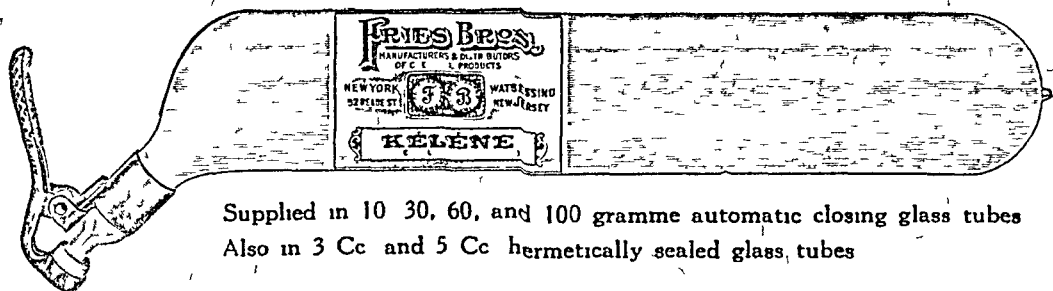
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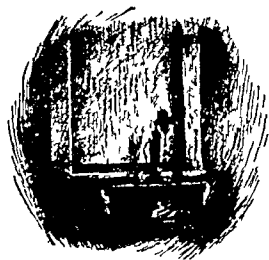
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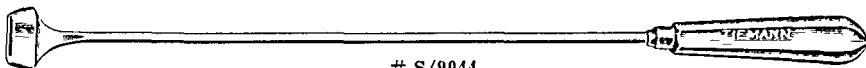
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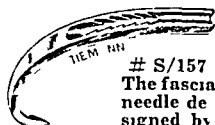
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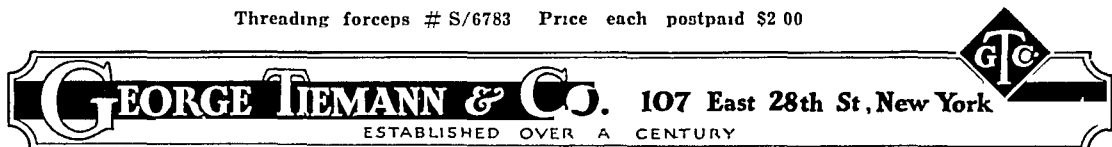
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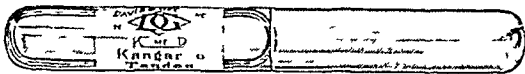
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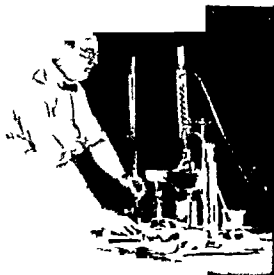


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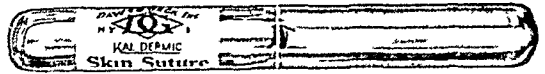


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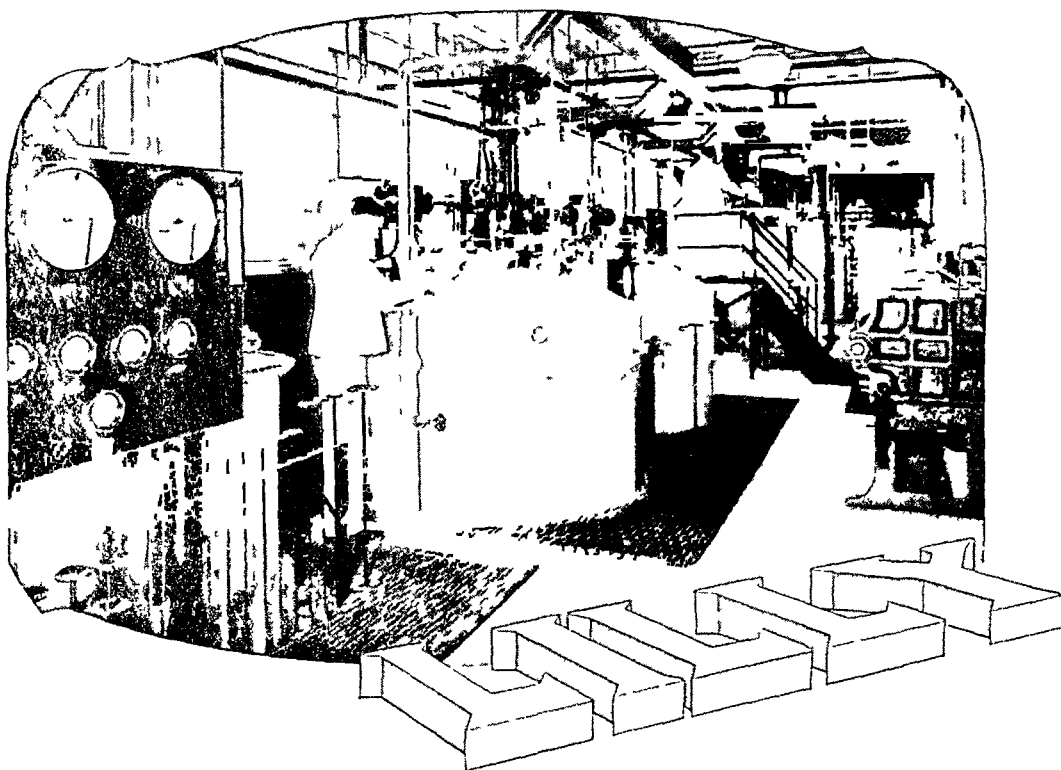
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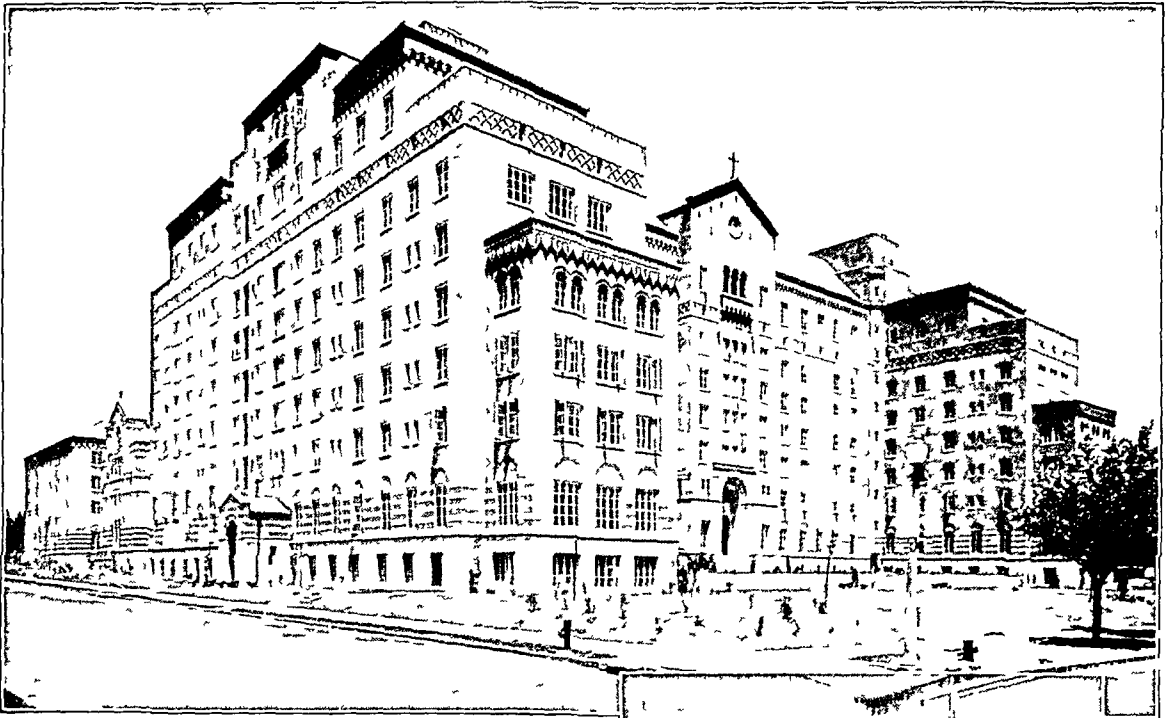
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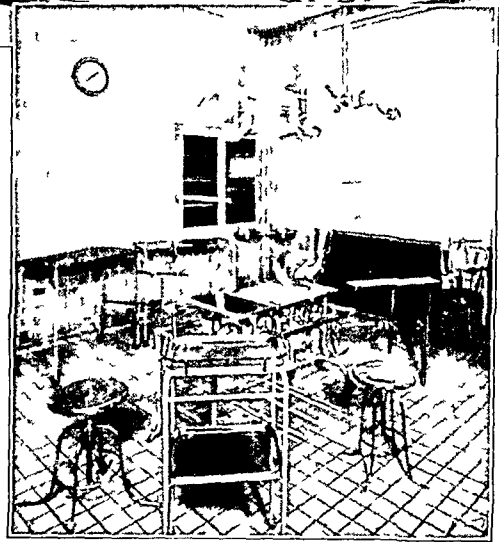
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abundantly when they are stripped of misleading details. Symbiosis is a good relation, parasitism is an evil one. Good and evil, of course, are relative terms. But once we have a standard by which reliably to judge biological activities and their results, we need not shrink from the attempt to discriminate between legitimate and illegitimate developments, and thus to introduce order into biology in the place of the present chaos and indeterminateness of jargon. The claim made by some that biology is not a matter of values is preposterous. It is a species of scientific fatalism no longer warranted today. The very term 'survival of the fittest' involves a value-judgment. There is no cause for fatalism or pessimism on a due appreciation of symbiosis, no cause to falter and to think that Nature sanctions crime equally with good conduct. True, in the course of evolution, legions of species have strayed from the symbiotic path and have elected instead that of least resistance—that of predacity or of parasitism. But it can be shown that they have declined accordingly, whilst others, which have persisted in a more honest course, have meanwhile gone forward."

On this basis, Rheinheimer offers a new theory of disease concurrently with that of symbiosis. He says "Disease, degeneration and extinction originate with failure of cooperation, be it between organs or species." Wheeler<sup>5</sup> states in an article on "Social Life Among the Insects" that "Living beings not only struggle and compete with one another for food, mates and safety, but they also work together to insure to one another these same indispensable conditions for development and survival." Hastings<sup>6</sup> says that "Life is not only a struggle for existence among half-starved individuals thirsting for each other's blood but plants and animals of different kinds cooperate to a much larger extent than was formerly supposed."

One of the best examples of symbiotic existence is the lichen. A lichen is formed by the intimate association of a fungus and an alga. They perform an important function in serving as the advance guard of vegetation by reaching out over the desert and into the cold of the north and by climbing mountains to the snow line. They cover bare regions of land and are often followed by other vegetation. Fungi grow around and in the cortical layers of the roots of certain plants and trees. A still more important function is performed by nitrifying bacteria, such as *Bacillus radicicola*, which occur in the soil. They enter the root hairs of leguminous plants and grow within the roots, forming nodules. These bacteria take up nitrogen from the air and supply the roots with nitrates, accepting in return carbohydrate for their own nourishment. Bacterial mixtures play an extremely important function in the disintegration of animal bodies. Many other instances of these relationships could be cited but these will serve to indicate the importance of the general laws of symbiosis without which life as it exists on the earth would cease.

Since the early days of bacteriology it has been observed that different species of bacteria frequently exist together but very few reports have been made with regard to the effects that these organisms have on one another. Since the time of Koch<sup>7</sup> much greater importance has been placed upon obtaining organisms in pure culture. Even during the Great War, when wound infections with mixtures of organisms were commonly observed, there is very little evidence in the literature that much thought was given to the symbiosis of these organisms. In the intestine of man and of animals bacteria have

sterilized either by filtration or heat, so that they believed that the second organism did not act on the end-product of the first but upon some intermediate product. Sherman and Shaw<sup>18</sup> demonstrated the synergism of two organisms in the production of propionic acid. *Bacillus acidi propionici* which is the essential organism for the production of "eyes" and the characteristic flavor of Swiss cheese, will produce a very much larger amount of propionic acid in association with several other organisms than it will alone in a medium containing lactose. The associated organisms may be either lactose fermenters or nonlactose fermenters. Ishikawa<sup>19</sup> made some very interesting observations on the synergistic action of certain bacteria. He combined not two but three different species. He confirmed the findings of others that an acid former and a gas former would together produce gas from a complex carbohydrate but if nitrogenous substances were added to the carbohydrate medium the two organisms which ordinarily, in symbiosis, would break down the carbohydrate to form gas would not do so unless there were present also a proteolytic organism to initiate the breaking down of the proteins present. The products of protein digestion favor the activity of the amylolytic enzymes. Thus, we have a synergistic action which requires the presence of three different kinds of organisms but in this instance the activity of the proteolytic organism takes place *before* and not necessarily *with* the activity of the other organisms. Theobald and Dorothea Smith<sup>20</sup> have shown that just as there is synergism with certain organisms in the production of gas there is a corresponding antagonism with other organisms. They observed that bacteria of the paratyphoid group may be divided into two classes according to the behavior of four-day cultures in lactose bouillon after a second inoculation with certain types of *Bacillus coli*. *Bacillus coli* produces gas after true hog-cholera bacilli have grown in the medium but produces no gas after other paratyphoid bacilli. Likewise Speakman and Phillips<sup>21</sup> found that characteristic production of large amounts of lactic acid by the association of *Bacillus granulobacter-pectinovorum* was prevented by some factor produced in *Bacillus volutans* cultures. *Bacillus granulobacter-pectinovorum* usually carries the fermentation down to acetone and butyl alcohol but it stops with lactic acid if *Bacillus volutans* is present. Burri and Stutzer<sup>2</sup> found that two organisms when combined would produce nitrogen gas from nitrates when neither would do it alone. They showed that one reduced the nitrate to a nitrite and the other produced free nitrogen from the nitrite.

#### BACTERIAL SYNERGISM IN PROCESSES OF DISEASE

There are very few proven instances of disease processes due to the synergism of two species of bacteria. Castellani<sup>15</sup> believes that a good many symptoms in certain diseases which are ascribed to the causative organism are really due to the association of symbiotic organisms. Among these he includes excessive tympanites with typhoid fever. He lists three definite disease entities which are due to the synergistic action of two organisms. *Trichomycosis nigra*, a disease of the hair of the axillary and pubic regions, is caused by a fungus *Nocardia tenuis* and a coccus *Micrococcus nigrescens* neither of which can alone produce the disease. *Trichomycosis rubra* is caused by the same fungus plus a different coccus. *Stomatitis cryptococcus-bacillaris* is a disease of the mouth caused by two organisms one a fungus and the other a bacillus. Vincent's angina has been considered a disease of symbiotic organisms, a fusobacterium and a spirillum. Some authors have believed them to be morphologic variations of the same organism. Knorr<sup>23</sup> who has made some interesting laboratory studies with regard to this disease, believes them to be different organisms living in symbiosis, but he has shown that in conjunction with some of the mouth streptococci they perform certain functions which they cannot perform when separated from the streptococci. When cultures are



could not produce it alone. Certain mixtures were necessary and it was a true synergistic effect. Kammeier also studied the production of hæmatoporphyrin from hæmoglobin. He found porphyrin in the fluid from lung abscesses and when he cultured the organisms present he found that they were able to produce hæmatoporphyrin from hæmoglobin only when they were in symbiosis.

Last year I reported to the Society of Experimental Biology and Medicine some striking examples of synergistic action in the production of hæmolysis on blood-agar plates.<sup>29</sup> The phenomenon was noted with three different groups of organisms: a pair of aerobes, a pair of anaerobes and an aerobe with an anaerobe. In the exudate from a case of chronic empyema of tubercular origin, I found among other organisms present, a double-zoned *Staphylococcus aureus* and a diphtheroid bacillus. On blood-agar plates the colony of the double-zoned staphylococcus has a narrow zone of clear hæmolysis immediately around it and a wide zone of partial hæmolysis about 8 to 10 times the diameter of the colony. It so happened that when the colonies were fished from the original blood-agar culture to a fresh plate the diphtheroid bacillus and the double-zoned staphylococcus were streaked side by side. After incubation this plate showed that on the side toward the diphtheroid bacillus the outer zone of the staphylococcus colonies was completely hæmolysed over an area very evidently under the influence of some diffusible substance or physical force emanating from the colonies of the diphtheroid bacillus. Immediately around the diphtheroid colonies no change in the red cells was visible.

In order that this effect might be brought out more clearly a design was made on another plate by alternately dotting with the two cultures. Photographs of those plates show the effect produced by these two organisms when in juxtaposition. (See Fig 1.) It was found that control nonhæmolytic colonies of several other species did not have this effect but this diphtheroid bacillus had the same effect on the outer zone of both hæmolytic and non-hæmolytic *Bacillus welchii*. If the staphylococcus was planted alone and incubated for twenty-four hours and the bacillus was subsequently planted on the same plate, the same hæmolysis of the outer zone took place. Some months later in culturing a specimen of improperly prepared surgical catgut, two anaerobic organisms were found which had exactly the same relationship to one another. They were a double-zoned hæmolytic strain of *Bacillus welchii* and a non-hæmolytic strain of *Bacillus sordellii*. The plate after anaerobic incubation gave the same appearance as the two aerobic organisms gave before.

Later, a third example of the same phenomenon was observed when, from another specimen of catgut, a hæmolytic strain of *Bacillus welchii* and a hæmolytic strain of *Bacillus subtilis* were found. The *Bacillus subtilis* colony had a narrow zone of clear hæmolysis about it and an outer zone of influence not visible until it came in contact with the outer zone of the hæmolytic *Bacillus welchii* colony which it completely hæmolysed. (See Fig 2.)

In our recent study of the organisms in raw catgut we found two instances in which a combination of the organisms found in a single specimen of catgut produced a lethal effect when injected into an animal while the



When reference has been made to our report by later authors with the exception of Brunsting<sup>40</sup> some doubt has been expressed with regard to the syneigistic bacterial etiology of the disease suggested by our bacteriologic study. Clinically, however, the distinctive cases all behaved in the same way and were characterized by extreme pain and tenderness and a slowly spreading gangrene not yielding to repeated conservative operations but finally yielding to radical and extensive removal of the lesion [except two of the cases, which went on to a fatal termination]. The disease may be said, therefore, to be a definite clinical entity.

#### RECENT CASE

In January of this year a man of thirty-five came to the Presbyterian Hospital complaining of a diffuse abdominal pain of two weeks' duration. On examination his abdomen showed slight tenderness over both lower quadrants with a mass that could be felt low down close to the mid-line slightly more on the right than on the left. This was more readily felt by rectal examination. Dr. Richmond Moore, who was on call for emergencies, saw the patient and advised immediate surgical intervention. At operation an abscess was found in the pelvis containing 30 to 40 milliliters of thick, green pus. The coils of the intestines were so matted together that it did not seem wise to explore extensively. The appendix region could not be found and the origin of the abscess could not be determined. The abscess was drained by means of two cigarette drains and a large rubber tube. The peritoneum and the posterior sheath were closed with continuous sutures of chromic catgut. The anterior sheath was sutured with chromic mattress sutures and two silkworm-gut retention sutures were placed in the upper part of the wound. On the day after operation the drains were soaked with exudate from the abscess. Cultures from the exudate yielded *Bacillus coli*, *Bacillus welchii* and a non-hemolytic microaerophilic streptococcus. On the third day post-operative a note was made on the chart to the effect that the wound was infected. The cigarette drains and the tube were gradually shortened and removed. On the eleventh day post-operative, it was observed that there was infection around the retention sutures and on the thirteenth day it was noted that "the wound had a carbuncular appearance" in the upper half. The retention sutures were removed but the swelling and necrosis continued to spread both right and left from the upper half of the wound. Up to that time the patient had been a jovial, uncomplaining individual, but he then began to complain of intense pain which increased in severity and remained constantly present, aggravated by any movement or any manipulation. His temperature did not rise. His blood count was low but the local gangrenous process continued to spread in both directions in spite of what was thought to be adequate drainage of the margins by the removal of large pieces of necrotic tissue. From day to day pieces of slough were cut away but it continued to spread. On the twenty-seventh day, upon my return from a vacation, I was asked to see the patient. The appearance of the lesion at that time is well shown in Mr. Fernberg's drawing (See Fig. 3). The lesion showed such a striking resemblance to the previous case of Doctor Brewer's that the treatment which was successful in that instance was advised, namely, wide excision of the lesion and prompt application of antiseptic fluids (See Fig. 4). This resulted in a prompt disappearance of the infection, the denuded area granulated over rapidly and on the eleventh day following this operation, the wound was covered with Thiersch grafts, which took nicely (See Fig. 5). Epithelization was complete on the twelfth day, which was twenty-four days after the excision of the lesion and fifty-one days after the original operation.

#### BACTERIOLOGICAL STUDY

Needless to say, I was delighted to have the opportunity of studying this interesting lesion again bacteriologically. Inasmuch as the disease had spread

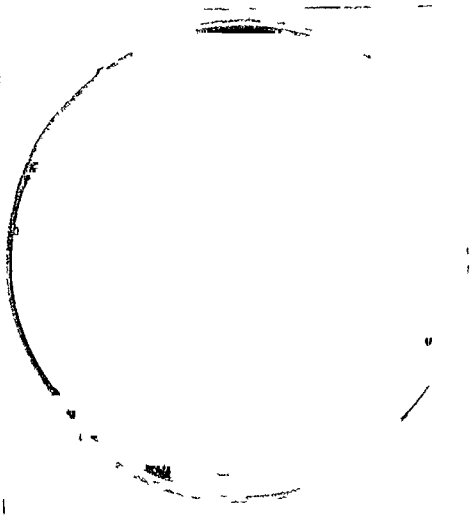


FIG 6—Pure culture of the microaerophilic nonhemolytic streptococcus from the periphery of the lesion, cultured anaerobically on a blood agar plate



FIG 7—Mixed culture of the streptococcus and *Staphylococcus aureus* from the gangrenous margin. The plate was incubated for twenty four hours anaerobically to permit the growth of the streptococcus (pin point colonies) and then for twenty four hours aerobically to permit further growth of the staphylococcus (large colonies)



FIG 8—Lesion in a dog forty eight hours after injection. Marked swelling and redness with early gangrene in the centre at the site of injection of 2.5 cubic centimetres of the culture of streptococcus mixed with 2.5 cubic centimetres of the culture of staphylococcus. No swelling on either side at the site of injection of 5 cubic centimetres of pure cultures of the streptococcus (X) and the staphylococcus (O)



FIG 9—The same as Fig 8 on the fifth day. The gangrenous skin has separated. Undraining and swelling of the surrounding skin persists

tically no reaction while the staphylococcus caused only a moderate swelling. The lesion in dogs and guinea pigs is shown in Figs 8, 9, 10, 11 and 12.

Having confirmed to the letter the findings in our previous case, it seemed to be worth while to go farther and try to find out something of the mechanism of the reaction. A microscopic study of the lesion revealed the fact that there was an extensive fragmentation of the dense subcuticular connective tissue and a heavy cellular infiltration of the subcutaneous fat. There was no evidence of a thrombosis of blood-vessels. The vessels were universally dilated and filled with blood with a large number of polymorphonuclear cells clinging to the walls. From a morphologic viewpoint it seemed evident that the gangrene was due to a direct action of some lytic substance on the tissue rather than to a cutting off of the blood supply. Gram stains of the tissue revealed masses of Gram-positive cocci toward the center of the lesion and scattered organisms in diplo form or in short chains out toward the periphery. No amoebæ were seen such as have been reported in certain somewhat similar ulcerative lesions.<sup>41</sup> These cases were not studied for the presence of anaerobic organisms. It may be that they were of synergistic bacterial etiology and were secondarily contaminated or infected with amoebæ. Dr F W O'Connor of our department of tropical diseases has confirmed the absence of amoebæ in our two cases.

In our study we have attempted to answer the following questions. What was the source of these organisms? Have they any cultural peculiarities or biologic properties which will serve to demonstrate their synergism *in vivo*? Does one organism prepare the ground for the other, or must they work together? Is the gangrene a phenomenon of sensitization? Can the lesion be produced by bacterial filtrates or by the filtrate of one organism acting as an adjuvant to the other organism? Is the combination a specific one or will other combinations produce the same effect? Can a similar effect be produced in certain organs or in the peritoneum as well as in the skin? We have not answered all of these questions but present the results of our study as far as it has gone.

Inasmuch as the streptococcus was found in pure culture in the advancing zone of the lesion in both cases, it seems reasonable to suppose that it is of fundamental importance in the production of this particular lesion, or I might say these particular cases.

The microaerophilic streptococcus is one of a group which occurs frequently in the human intestine and in peritoneal exudates. It is usually missed unless careful anaerobic cultures are made. In a recent bacteriologic study of a series of cases of peritonitis following perforation of the appendix or gut, we found that intestinal streptococci form a large percentage of the bacterial flora of the peritoneal exudates.<sup>42</sup> There are many species and varieties of streptococci in the intestine including the heat-resistant enterococci, the green and also the nonpigment-producing streptococci, true anaerobic streptococci, and a group of microaerophilic streptococci which prefer an anaerobic environment and for the first cultivation must be obtained by anaerobic methods but after several transplantations on artificial media they will grow on the aerobic plates as well. From our peritoneal exudates we cultivated these organisms many times and Weinberg



FIG 11—The lesion in a guinea pig. An anteriorly (at X) 2 cubic centimetres of streptococcus culture were injected. Posteriorly (at O) 2 cubic centimetres of staphylococcus were injected without effect. In the centre 1 cubic centimetre of each was injected with extensive gangrene. The slough has separated—sixth day



FIG 12—The lesion in a guinea pig with the streptococcus and a control staphylococcus—the same amounts of culture as indicated in FIG 11



FIG 13—The lesion in a guinea pig with the area of the staphylococcus injection (O) approximating the area of the mixed culture injection. In this region there is a semilunar area of necrosis. The area of streptococcus injection (X) is unaffected

cocci spread more widely than the staphylococci and reach the site of the staphylococcus injection in sufficient concentration to produce the lesion. Or it may be that it takes a smaller dose of the streptococcus to activate the staphylococcus than *vice versa*. This effect is shown in Fig. 13.

When doses which are adequate to produce the lesion in the skin were injected into the peritoneum of guinea pigs, there was no evidence of disease. The peritoneum was able to take care of large numbers of bacteria in a free broth culture but when the culture was incorporated with barium in a cylinder of agar, the combination of the streptococcus and staphylococcus caused a progressive loss of weight, resulting in death in four days. The staphylococcus alone with a double dose resulted in death two days after the combination but without showing any illness the day before death. The streptococcus alone produced no ill effects whatsoever.

The fact that this type of streptococcus is so frequently found in lung abscesses led us to attempt to produce this lesion in animals. A suspension of equal parts of barium sulphate and 2 per cent melted agar was sterilized by boiling and then cooled to 40° C. This suspension was poured into three small bottles and the cultures of streptococcus and staphylococcus were then added separately and together. The mixture of staphylococcus and streptococcus contained half of the number of each organism which was used in the pure cultures. After thoroughly mixing the cultures with the barium and agar it was allowed to solidify. With a large syringe needle a cylinder was then cut about 25 millimetres in length and 1.5 millimetres in diameter. To ascertain its presence in the needle, it was first expelled into a sterile dish and then sucked up into the needle again. With a small amount of saline in the syringe these plugs were then injected into the jugular veins of three rabbits. X-rays showed that although they broke up to some extent in passing through the heart they generally were caught in one or both lower lobes. X-rays of the lungs were then taken at intervals of two to three days. Five days after injection, the rabbit which received the mixture of organisms began to lose weight and the X-ray film showed an infiltration of the lungs around the infected emboli. This rabbit continued to lose weight while the others appeared normal. Later X-rays showed progression of the lesion in both lungs. After fifteen days, however, the X-ray of the rabbit receiving staphylococcus alone showed infiltration around the emboli. The animals were then sacrificed and the lungs were removed. All three showed adhesions of the lung to the diaphragm in the region of the emboli. The streptococcus embolus produced only an infarct. The staphylococcus alone produced a pneumonitis involving the lower third of both lungs. The combination of organisms resulted in a much more extensive involvement—at least three-quarters of both lungs being consolidated. This study will be carried further but these experiments suggest that in the lungs also these organisms have some adjuvant action upon one another.

#### DISCUSSION

In connection with the two cases of progressive gangrene of the abdominal wall, these points should be emphasized. Both occurred following

explanation of the profound toxæmia of some cases of intestinal obstruction and certain cases of peritonitis which toxæmia may be absent in other cases, apparently similarly obstructed or with an equally extensive peritonitis

The production of a skin lesion with doses which are well tolerated by the peritoneum may be explained by the relative speed of absorption from those two tissues or a special predilection of the staphylococcus and streptococcus for the skin and subcutaneous tissues. The production of disease within the peritoneum with much smaller doses when contained in an agar plug is consistent with the former hypothesis

The production of hæmatoporphyrin in lung abscesses and urobilin in the intestine by the combined action of bacteria are again indices of other possible reactions which cannot be so easily demonstrated but which may be much more significant as factors in disease

When two or more organisms are associated in the production of a disease process in man, they are in symbiosis with one another but are parasitic with respect to the man. The fact that they produce the disease in combination when they cannot do it alone suggests that their association is of mutual benefit to them while it is harmful to the common host

Clinically it has been observed repeatedly that mixed infections are usually worse than infections with a single species, for example—tendon-sheath infections with streptococcus and staphylococcus and tuberculosis with pyogenic empyema, arthritis or lymphadenitis. We recently observed in our post-operative wound infections following clean operations that the majority of serious infections yielded more than one species of organism while the majority of trivial cases yielded a single organism. Human bites frequently produce alarming and serious infections when the only organisms which can be obtained on culture are nonpathogenic in pure culture. The complications of measles and whooping cough with their "secondary invasion" of other organisms (particularly streptococci) might well be studied from a symbiotic viewpoint. These clinical observations have been common but very little study has been made to determine whether they represent a summation of effects or synergistic phenomena

#### SUMMARY

We have tried to emphasize the importance of symbiosis in various processes of life

We have given some illustrations of the synergistic action of bacteria in certain *in vitro* experiments in the laboratory which may have no clinical significance but which indicate the possibility of other synergistic effects which may not be so easily demonstrated but which are significant in disease processes

We have reviewed the synergistic diseases and the disease processes which have been observed by other authors and have added certain observations of our own, namely

(1) The hæmolytic synergism of two organisms found in the exudate in a case of chronic empyema



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# SPINA BIFIDA

A CLINICAL STUDY WITH A REPORT OF TWELVE PERSONAL CASES

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THE successful repair of any serious congenital defect in the new-born ordinarily carries with it its own reward To feel that one has overcome a defect of nature on behalf of an unfortunate infant should beget a gratifying self-satisfaction With regard to most of the operable congenital defects this is true, but in the case of spina bifida, my personal experience has not always been entirely satisfactory Although the operations have all been technically successful, there are some among those patients who, it seems to me now, would have been better left unoperated upon That a single case of paralysis of bladder and rectum in the new-born, associated with myelocele of any variety, has ever been cured by operation is not likely A somewhat extensive reading of the literature has only strengthened this opinion And since it is highly probable that all such paralyses are due to defective cord development, any cure by operation is not likely in future Therefore, the author, with regard to these babies, like the first surgeon pioneers in this field, von Recklinghausen and Hildebrand, feels that it is better to leave them unoperated upon

The incidence of spina bifida is usually placed at about one in each thousand births Harrar, in 1916, found fifty-nine cases in 91,600 at the New York Lying-in Hospital The report of the London Clinical Society's Committee for the study of spina bifida in 1885 gives twenty-two in 22,293 births at the Paris Maternité In an examination of pathologic embryos, Mall found it twelve times in 163 and Panum thirty-eight in 404 From this Mall deduces that for each case which goes to term at least five are aborted

The condition is said to have been named by Tulpus (Ranke) in 1641, but it was not until the early years of last century that it became of much scientific interest The younger Saint-Hilaire, in 1832, described it and refers to the various types, even the rare anterior variety and the syringo-myelocele In fact, he insists that the name spina bifida can be *correctly* applied only to those of the anterior variety The name "fissure spinale" he gave to the usual varieties He refers to it as an arrest of development similar to anencephalus, describes the usual accompanying deformities and discusses the different varieties and their most common sites Cruveilhier (1849) refers to it as "une hernie aqueuse" sometimes containing the cord in the sac He asserted it was *not* due to hydrocephalus, which it often accompanied, they were both due to a common cause—"hydropsie" Forster (1861) made certain observations, and Rindfleisch (1863) discusses the condition, especially the anterior variety He argued that this was a consequence of the failure of

one to two centimetres wide and of variable length lying in the centre of the back. This strip is not covered by the normal surface epithelium. It has a moist granular appearance and flakes of fibrin or inspissated mucoid, or even crust-like plaques may be seen on it. Microscopic examination reveals columnar or cylindric epithelium, unless this has been rubbed off or ulcerated. Clear fluid wells slowly up from its centre only if the cord is cleft to the canal. Around the margin of this red strip, the surface is covered usually by a thin, pearl-gray, scar-like pellicle. This usually thickens as it passes outward—may become quite hard and scar-like—and joins the normal skin abruptly. There may be no tumor at all, the surface may even be depressed, groove-like, but most often this whole abnormally covered area, with the adjacent healthy skin, protrudes more or less, depending on the tension of the subjacent cerebrospinal fluid in the arachnoid space. When a tumor exists in such a case, it is never pedunculated but always has a wide base.

The above type of spina bifida without tumor has been called myelocele, and with tumor, myelocystocele. It would simplify matters to refer to them as plane and cystic myelocele. In all these cases it is highly probable there will be accompanying paralyses. Such paralyses are due to lack of development of the cord centres and not to the cord's position, and they are therefore, not likely to be benefited by operation. Or the failure of union of the sulcus may reach from the surface of the body to the cord only, involving the arachnoid or pia or both. In such, the cord is found in the sac where it usually adheres to the roof and sometimes terminates in it. (Cases I, II, and XII.) This type is called the myelomeningocele. The surface of such a tumor may or may not be entirely covered with epithelium—a granulating area or several—may exist along its summit, and the same thin pearl-gray coat seen in the myelocele is sometimes found. It is not usual but it does happen, that the normal skin may cover a tumor of this type, *i e*, a cystic tumor containing the cord. The cord is not always attached to the roof, but may lie free in the sac.

A structure much resembling cord in gross appearance, except that it has no nerve roots attached to it, is sometimes seen in this form of tumor. One end of it is attached to the cord, the other to the roof of the sac, which it causes to dimple in. It has been found in the dorsal region (Case VII), and in the lumbosacral region (Case X). When found in the lumbosacral variety, it may contain a canal continuous with that of the spinal cord and open out on the roof so as *to look like* a myelocele. These processes were first noticed by Forster. On section they are found to contain nervous tissue toward the inner end, and skin elements toward the outer—or they may retain the nervous elements throughout. Those found along the continuity of the cord are probably remains of the fused but unabsorbed walls of the neural groove at that level. Those occurring as a continuation of the cord represent the lower coccygeal segments of the embryonic cord which should have remained only as the filum terminale. If such a process is canalized throughout, cerebrospinal fluid is discharged at the summit of the tumor. This and

A properly developed cord may not function because of traction, *etc* Such a cord carefully released and restored to its bed may possibly function normally I have found no well-authenticated case, but improvement has been noted But an "opened-out" cord in the roof of the sac is another matter Such a cord is not normally developed and the operation for its replacement in the canal (it can be successfully accomplished, see Cases IV, V and IX) must necessarily traumatize it and still more curtail its function Therefore, to expect to benefit an existing paralysis by operation in the case of myelocoele, plane or cystic, is a vain hope

A paralysis of both legs or of one may be a great handicap None the less, one may live a very worthwhile, and even a happy life, whether viewed from his own standpoint or that of his associates

A paralysis of bowel and bladder, however, that causes incontinence of faeces and urine, is a far different condition This practically condemns the patient to a life of ostracism which begins when he reaches school age and lasts the remainder of his life Paralysis of both sphincters—anal and vesical—may occur with only very slight paralysis elsewhere (Case I) It is conceivable that they alone may be paralyzed

The absence of the anal reflex is a constant clinical sign of paralysis of the anal sphincter, but the reflex may be absent because of sensory paralysis alone However, a paralyzed sphincter gapes and has a loose feel to the examining finger

No one, so far as I can learn, has yet reported a single case wherein a congenital paralysis of bowel or bladder was cured by operation for spina bifida The history of Case II would seem to contradict this, but it will be seen that although the statement is made that "the bowel moves constantly," it is also stated that "anal reflex is present" This child still has a weak sphincter, but has not incontinence—and I think he never had

Coffey has done a great deal toward the perfection of a technic for the successful transplantation of the ureters into the bowel Such an operation in the presence of a paralyzed sphincter and would likely not improve the patient's condition

For a paralyzed anal sphincter alone, a sigmoidostomy properly performed ameliorates the condition of the patient Unfortunately, in spina bifida the paralysis of sphincter and is not likely to occur without accompanying vesical paralysis In such a case a sigmoidostomy following or followed by caecal or sigmoid implantation of ureters would probably not improve matters

For a paralyzed vesical sphincter alone, however, Coffey's operation seems to be the best so far developed

In spina bifida, to operate or not to operate is the question one must decide Will it be better under all circumstances to operate than to leave the case to nature?

What will happen to those left unoperated upon? The patient with spina bifida of the myelocoele or myelocystocoele variety, if left alone, will most likely soon die If there is leakage of cerebrospinal fluid, meningitis

Prevention of contamination both during and after operation, I feel, is helped somewhat by the rubber dam of Eastman. He sewed it to the skin. I have applied it with rubber cement and it is kept on for days. Von Bergmann covered all with collodion dressing.

The length or duration of the operation is important. Nothing should be done that is not necessary. The first step should be an incision into the sac. This is for the purpose of making the diagnosis exact and complete. Such incision should be longitudinal, near the anterior end of the tumor, and 1.5 to 2 centimetres from the mid-line. This will not injure cord nor nerve roots. After opening the sac one can quickly determine the site of cord or nerves if either be present. In further progress of the operation

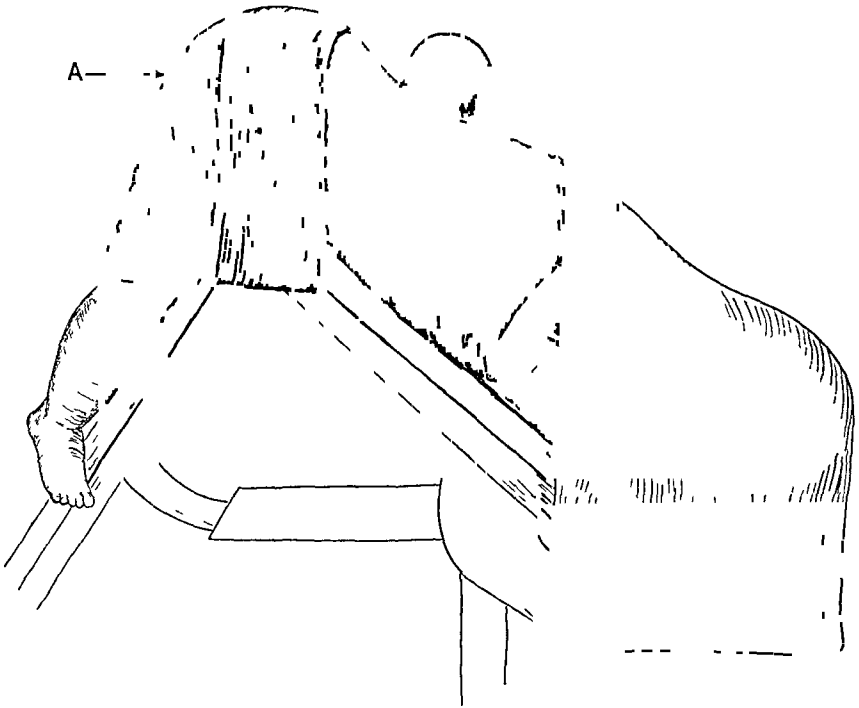


FIG 1—Position during operation and for some days afterwards. A—Rubber sheet fastened to the skin with rubber cement.

he now knows at least where not to cut. If nerves pierce the sac wall they course through the tissue between skin and sac on their way to their respective foramina of escape, and may be cut if one is not aware of this. I do not know whether it would make any difference if they were cut.

An elliptical incision (Harmer), its long axis transverse, is the kind I prefer. It is just of such a width as will conserve as much as possible of the normal skin to facilitate closure. It has the advantages that, when closed the deep and superficial sutures are not in the same plane, and leakage of cerebrospinal fluid is not so likely, and also the edges are better supplied with blood than are those of a vertical incision. Beginning at the angles, the skin and fat are carefully reflected until the pedicle or base of the sac is reached (Fig 3), taking especial care when exposing the caudal aspect of



FIG. 3—The skin and fat are lifted up from the edges toward the centre, taking care to avoid cutting nerves that lie on the outside of the pedicle. They are sometimes found below and laterally.

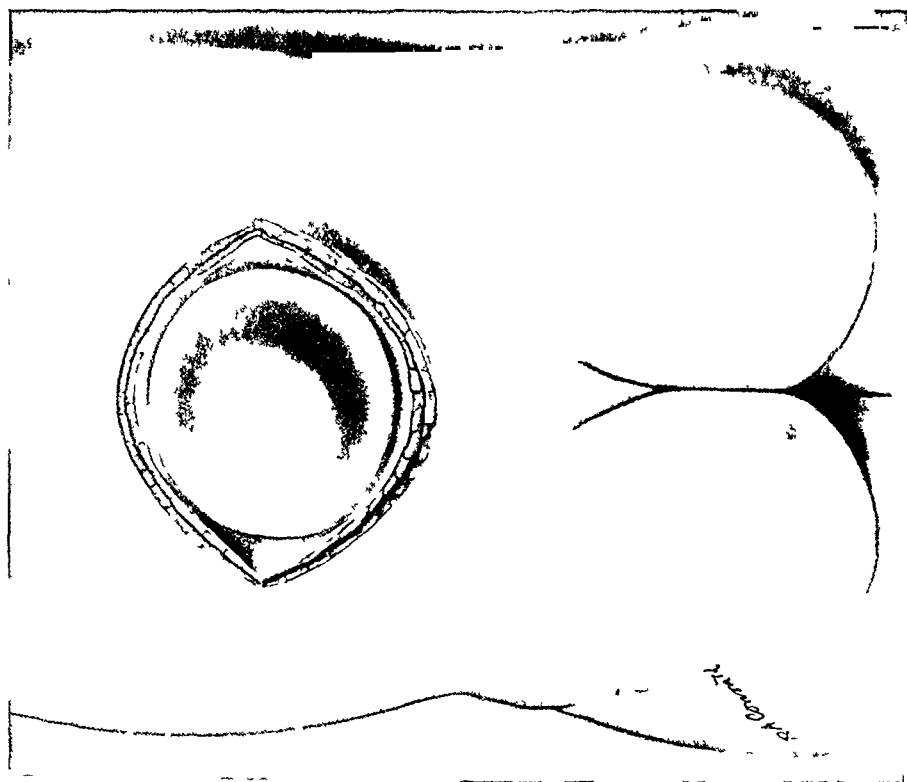


FIG. 2—The tumor is excised transversely saving as much of the normal skin as possible. The artist has made the long axis relatively too short.

"dimpled" at the summit, and from the edge of the dimple through a small opening, clear fluid is exuding drop by drop. The tumor, for one-third the distance from this dimple to the base, is covered with a thin, pinkish-gray, dry membrane which is continuous with the normal skin, which covers the lower two-thirds of the tumor.

Doctor Spain informed me that at delivery, the tumor was tense and glistening and that there then was no leakage, and that twelve hours later the sac was leaking and wrinkled instead of tense. When first seen by me, the day before operation, the tumor was only moderately distended, its surface was soiled with recent feces, and the clear fluid referred to was issuing from the opening at the edge of the dimple at the rate of about twenty drops per minute. The dimpled or puckered part had an ulcerated or raw appearance. There is an increased redness in the pinkish pellicle at the edge of the opening and the exudate on the raw surface looks like pus. When the baby cries the tumor increases in size, and the fluid flows faster. Feces and urine escape from time to time. The anus seems open—it is certainly not drawn in and puckered in the normal way. The limbs are kept in strong flexion, and the baby seems to move them voluntarily.

Operation was performed when the child was approximately sixty-six hours old. The baby was held in face-down, head-down position, its feet and legs drawn downward over the end of the table, so that the axis of the body was at about forty-five or fifty degrees with the horizon, and the axis of the thighs at right angles (or less) with that of the body. Ether was given on the open mask. The field was sterilized with half-strength tincture of iodine, removed with 95 per cent alcohol. The Percy cautery at a black heat was lightly applied to the edge of the opening in the pellicle, and to the raw surface in the dimple, and again tincture of iodine was applied over the burned area, and round about over the tumor.

The tumor was removed by a transverse excision, elliptical, cutting through the skin covering the tumor half-way between summit and base. Sac and skin attached to it were removed. Some nerves were cut, as they lay imbedded in the sac wall. The cord was attached near its end to the dimple in the summit of the sac, and on cutting it free, it bled rather freely from a single vessel. This was ligated, and the opening in the dura (?) closed transversely, serosa to serosa, with continuous plain No. 00 catgut.

The defect was about two inches wide at its middle. A transverse incision was made through skin and subcutaneous fat about three inches above the defect. The intervening skin and fat flap was now lifted up—as in Fig. 5—and the flap was slid downward and sutured to the lower edge of defect with interrupted silkworm gut and continuous No. 00 plain catgut (epidermal) sutures. The defect left above was dusted with bismuth subiodide powder and covered with a rubber strip. A dry dressing was applied over all. There was lost only what cerebrospinal fluid the sac contained, and the baby was in splendid condition.

The orders were to feed as usual and keep baby constantly in the position maintained during operation, to give paregoric for crying or restlessness.

The recovery was uneventful. November 20 the last sutures and dressings were removed, and November 21 the child was removed from the hospital.

The discharge note says the bowel does not move as often as before operation, and there is no bulging—there was no fascia flap used in this case. The leg movements were as before operation.

The further history is that at about the age of one year the feet were noticed to be in talipes varus position, and orthopædic appliances have been used more or less constantly ever since. At present, the child, now eight years old, is well grown for his age, and seems far above average intelligence. There is no sign of hydrocephalus, vision, hearing, speech and intellectual processes are excellent, nor is there any bulging at the site of the operation. The feet are in equino varus, the left in first and the right in

family There is a tumor in the mid-line of the back, in lumbosacral region, almost hemispherical, about half the size of a large lemon, elevated three-fourths to one inch above level of surrounding surface It is covered with normal skin for only about one-fourth inch above its base, the covering here changes from skin to a thin, pinkish, semi-transparent pellicle At the summit is a spot from which the epithelium is missing, and which is covered with a scab or crust The tumor has a translucency somewhat like that of apple jelly, and in the depths in the upper left quadrant and in the mid-line, are pinkish-white opaque masses On pressing the tumor, the pellicle dimples but fontanelle does not bulge, nor does baby seem to be distressed However, when the fontanelle is pressed upon, bulging can be felt in the tumor Anal reflex is present, bowel moves constantly There is no paralysis in lowers No hydrocephalus

*Impression—Meningomyelocele* With the idea of avoiding rupture of the thin-walled sac with ensuing meningitis, operation was undertaken at once

Under ether on the open mask, the surface was sterilized, the raw surface at the summit was touched with the cautery and slightly charred A transverse elliptical excision through normal skin at base of tumor, cutting the skin and fat only Reflected skin and fat upward from all around, till sac was exposed Opening sac, we found the cord and a mass of nerve roots rather "bunched up" and attached to the roof under the charred area The sac was cut away, removing a thin layer of cord tissue along with it As much as possible of the neck of the sac was left (all that was covered by normal skin) The roots and end of cord were pushed forward into the open canal The spot on end of cord, where it had been cut free from the roof (in the bottom of the dimple referred to) bled freely A small vessel was ligated, and the cord and nerve roots dropped back in the open canal Two flaps of lumbar fascia, one on each side the opening in the canal, their bases toward the mid-line, were lifted up and turned over backward The sac was so thin and the opening so wide that no attempt was made to close it separately, but it was included in each flap The flaps were turned over backward and easily overlapped by about 1.5 centimetre The external wound was closed transversely, making a transverse incision through skin and fat, three inches above, and undercutting to relieve tension and allow sliding

Examination of the sac removed showed that where the cord had been cut from it, there was a whitish, hard area (on the inner surface of sac) This was less than one centimetre in diameter, and appeared to be made up of two symmetrical halves Microscopic examination by Dr R L Thompson "The material at summit of sac is nervous tissue and appears to be a part of the cord, the central canal of which is widely dilated Fusion of the dura with this can be made out No nerves appear in the section"

The child made an uneventful recovery In 1923, the following note was made "The baby's body is very large, the head is large and the brow projects There is lateral nystagmus, both eyes Pupils are equal and react to light The baby seems of normal intelligence It has not yet learned to walk alone There is spasticity of both legs, increased on attempts to stand The right foot is smaller No club-feet There is no bulging at the site of scar There is a well-marked 'post-anal dimple' about one and one-half inches from the anus There seems to be incontinence of urine—the diaper is constantly wet The skin about buttocks and perineum is red and it looks red and raw, with flat warts growing abundantly everywhere It does not bleed when rubbed or washed, nor does it seem tender This is said to have first begun during an attack of diarrhoea when the child was one year old" He was sent to the orthopaedist

The child was examined by me in July, 1930 At the site of the tumor there is no bulging whatever There is a distinct pulse feelable on palpation Halfway between the scar and the anus is a dimple On the under aspect of either buttocks, where patient sits, the skin has a peculiar scar-like appearance—no condylomata There is a thickening of the skin of the scrotum, and it has a peculiar, hypertrophied appearance The



CASE IV—St John's Hospital, Gen No 11222, admitted June 7, 1923 A girl baby three weeks old Three other children in family, all normal No history of deformities in family

There is a tumor in the mid-line of the back, about the lumbosacral region The tumor is hemispherical, about two inches in diameter The normal skin mounts on the sides of the tumor for about one inch, and then gives way to a thin, bluish-white, shiny membrane, which is continued to the summit There is a raw, granulating area on the summit, a little more to the right, about  $1\frac{1}{2}$  centimetres by 1 centimetre, and clear, watery fluid is coming out of the tumor at the upper edge of this area The raw area is covered with a grayish mucous matter The tumor bulges when the baby cries  
*Impression*—Cystic myelocoele

The anus is gaping wide open, the mucosa is everted about the edge, and seems gathered in little lumps There is no anal reflex and faeces are expelled from time to time The legs and feet look normal, and baby moves them apparently normally

The parents were informed that, left to itself, the child would most likely soon die of meningitis, that if the child lived it would probably lack control over the bowel whether operated upon or not They decided to have the operation performed

*Operation*—June 7, 1923 The skin was sterilized with half-strength tincture of iodine which was washed off with 95 per cent alcohol The operation was done in the usual position, body at an angle of forty-five degrees, head down—lowers hanging down, buttocks up—either given on the open mask The raw granular surface was cauterized and about fifteen cubic centimetres of slightly turbid fluid were aspirated A transverse elliptical excision was made through the normal skin, saving as much of this as possible above and below Dissection was made from the outer ends of the ellipse toward the mid-line, lifting skin and subcutaneous fat until the pedicle of the sac was encountered The sac was opened to the right of the mid-line, cephalad to the raw area The cord and cauda seemed to attach themselves to the roof under the raw area The sac was opened in the mid-line below the raw area and the most of the nerves were seen to end in the summit of the sac The pedicle of the sac was cut through transversely, leaving enough to close The nerves and cord (?) were cut from their termination in the sac and returned to the open canal

The opening in the dura was closed transversely, and a flap turned up from fascia on either side, their bases toward each other, one on each side of the opening The opening in the column was one inch vertically and three-fourths inches transversely, each flap about two inches long by one and one-fourth inches wide They were turned over until one lay over the other, closing the crani. They were sewed together with plain No 0 catgut A transverse incision, three and one-half to four inches long, was made through the skin and subcutaneous fat about three inches above the upper margin of the defect The skin and fat between this incision and the defect were undercut, and the Celsus flap thus made was slid downward and sutured to the lower margin of the defect with interrupted silk-worm gut, epidermal approximation with continuous fine "dermal" suture The defect left by sliding the flap was sprinkled with bismuth subiodide powder and a dry dressing applied

The baby was kept in the head-down, face-down position with lower limbs hanging down over a pillow for the next ten days The spinal fluid Wassermann was negative June 10, 1923—The baby seemed drowsy and there was a purulent discharge from wound Some of the sutures were removed June 12, 1923—The baby was better Culture taken June 10, 1923 showed *Bacillus coli* The further course was uneventful and the baby left the hospital June 27, 1923

The present condition of the child as reported by the physician in charge, Dr J H Cochran, of Gideon, Missouri, is "The child is living and well There is no control whatever over bowel or bladder A diaper is worn constantly The child is above the average intelligence There is a moderate talipes calcaneus, but she walks pretty well

*Comment*—It will be noticed that in many of the histories the statement is made that the sac wrinkles or does not bulge when the baby cries, as though there were not direct continuity with the general subarachnoid space, the defective area walled in, as it were. This is interesting when we remember that as late as 1885 a commission appointed in England agreed that the best results were to be expected from treatment by injection of iodine, *etc*

CASE VI—St John's Hospital, Gen No 12315, admitted September 7, 1923. Girl baby, seven days old. Father and mother had always been healthy. No history of any kind of deformity in family of either. One other child five and one-half years old, healthy. The mother had been "badly shaken up" in an auto accident during the sixth month of this pregnancy. The child does not move its legs. They hang flaccid when child is held up. There is a tumor, oval in shape, in the mid-line of the back. Its upper edge is just about the last ribs. Its long axis is vertical, about two inches long, and it is about one and one-half inches wide in its widest part. It is dark red or purple in color, is raised about one inch above the level of the back. It is covered with a very thin pellicle which is translucent and through which fluid can be seen. At its summit is a depression, also oval, with long axis vertical, nearly two centimetres long and half as wide. The floor of this dimple or depression seems pulled in, is yellowish-red and granular, and is not covered by the pellicle covering the tumor elsewhere. Nor is this floor translucent as the pellicle is. In the mid-line in the bottom of the depressed granular area, and rather nearer its upper end, is a tiny orifice from which a clear fluid wells slowly up. The upper edge of the depressed area comes to within one centimetre of the upper edge of the tumor and between these points in the mid-line, a structure thought to be the cord is visible through the thin covering in the translucent depths of the cyst-like tumor. There is no anal reflex. The anus has a loose, open appearance and urine dribbles from the vulva from time to time.

Confident that the condition was a cystic myelocoele and owing to the fact that there was paralysis of limbs and sphincters, operation was advised against, but was agreed to at the urgent request of the parents who felt they were morally obliged to make an effort to save the child. In sterilizing the raw area by the cautery in a case which seemed somewhat similar in appearance to this (Case V), there is no doubt the paralysis of the legs was made worse. I therefore decided to use tincture of iodine—3½ per cent—and after three minutes to wash this off with alcohol, and then to slice away a very thin layer of the raw surface from above downward under a stream of saline.

*Operation*—September 7, 1923. The baby was placed in the head-down position and anesthetized with ether given on the open mask. The sterilization was carried out as planned. The sac was opened in the mid-line above the depression and the cord was seen to emerge, normal in appearance, from the canal above and to terminate by attaching itself to the roof of the sac at the bottom of the depression, and, flattening itself out strap-like, it formed the roof of the sac in the bottom of the depressed area. Opening the sac in the mid-line below the depressed area, no cord could be seen but many strands identified as nerves and filum streamed from the under surface of the depressed area. None of the nerves followed or adhered to the lateral walls of the cyst, but all were traced forward toward the longitudinal hollow which we took to be the open spinal canal.

The cyst wall was cut away from the edge of the granular area. It was very thin but not so weak as one would expect. A transverse excision of the sac was now made just as close to the edges above and below as permitted by normal skin. Beginning at the ends of the ellipse, the skin with the subcutaneous tissue was dissected up each side toward the central longitudinal furrow until the membranes coming out of the canal were encountered. This membrane—dura?—was now followed into the wall of the cyst. On either side a good flap of it was obtained. There was very little bleeding

sac That its inner end should resemble the structure of the central nervous system and its outer that of the skin is, of course, what one might have expected, since the deep portion of the sulcus vertebralis forms the central nervous system The process found in the sac, I take it, was a complete cross-section of the lateral walls of the sulcus vertebralis, which remained unabsorbed Perhaps, in fact, this unabsorbed remnant was the cause of the spina bifida, but why it was not absorbed has not yet been told

CASE VIII—St Mary's Infirmary, Reg No 57195, admitted March 17, 1925 A healthy male, sixteen hours old There were five other children all living and well No deformities on either parent's side of the family There are no paralyses of any kind There is an enormous, somewhat spherical tumor attached by a pedicle to the mid-line of the back The pedicle reaches from about lumbar 3 to sacral 3 (about two and one-half inches) The tumor is covered with dusky red skin, and many large veins can be seen on its surface It is moderately tense, fluctuates on test, and seems to contain fluid It is translucent throughout It is quite five inches in diameter Compression causes bulging of the fontanelle No paralyses Meningocele It was decided to operate at once

*Operation*—The usual position, ether anæsthetic The cyst was punctured and 625 cubic centimetres of cerebrospinal fluid were slowly withdrawn before the sac was empty The sac was opened on its summit and a still further (estimated at thirty cubic centimetres) amount escaped A transverse elliptical incision was made, including the pedicle The skin was reflected and the pedicle exposed Looking into the sac through the incision in its summit, one could see nerves lying in the open spinal canal at the bottom of the sac Some of them were doubled up or folded upon themselves and some penetrated the pedicle wall below, escaping from the sac into the superficial tissue behind the sacrum The pedicle was cut long enough so that its edges would a little more than meet each other in the mid-line They were sewed together with continuous plain No 1 catgut Two flaps of fascia were now elevated (see Fig 4), turned backward till one overlay the other, and sutured in this position with interrupted mattress sutures of No 0 twenty-day catgut Skin closed by sliding (Fig 5)

By mistake the sutures were removed too soon and on the sixth day the wound reopened in the mid-line However, by careful dressing and using 2 per cent mercurochrome freely and continuing the head-down position, infection was kept out and by April 12, 1925, the child was taken home completely well The child at present is perfectly normal No sign of hydrocephalus

*Comment*—While this is an example of meningocele, and although it was entirely covered with normal skin, it was of such a size that it most surely would soon have become traumatized or ulcerated Nothing was to be gained by waiting and it is very well known by all who have had much experience with operations on babies that there is very little shock after operations done during the first hours of life

CASE IX—St Mary's Infirmary, Reg No 60432, admitted November 10, 1926 A female baby, seventeen days old Seems healthy Has a rather large head—hydrocephalic?—but no bulging of fontanelles The baby was normal delivery, full term, eight pounds There is a tumor in the mid-line, in upper lumbar region It is about three inches in diameter, circular in outline, and about one and one-fourth inches in height The skin covering it is of a peculiar, purplish-red, and ascends half way to the summit, where it gives place to a thin, gray-white membrane Along the mid-line at the summit over an area about 1.5 by 2.5 centimetres there is no epithelial covering The surface here is granular and red in color and from this surface, occasionally, a drop of clear fluid comes No opening can be seen Pressure over the tumor is not felt over fon-

structure was attached to the roof of the sac, under the funnel-shaped dimple in the mid-line, previously mentioned. The cord-like structure was cut free from the roof, and turned back into the spinal canal. It was necessary to remove the vertebral arch below the pedicle of the sac in order to do this without squeezing or crushing it. The pedicle of the sac was left just long enough so that its serous surfaces could be apposed in vertical mid-line closure. Two flaps of lumbar fascia, bases toward each other and as close as possible to edge of bony defect, and long enough to cover the defect, were turned over backward, one to overlap the other and close the defect. The usual sliding closure was then made. The recovery was uneventful and the child is at present quite normal in all respects.

*Comment*—In this case cerebrospinal fluid (?) had been escaping from the tumor for at least two months and yet the child remained quite well. Other such are recorded by Fincham and Hoon. The structure projecting which “looked like the end of the cord devoid of nerves” perhaps should have been removed. Section through the roof at the place where this structure had been detached showed “Tissue covered by squamous epithelium. The sub-epithelial tissue consists of granulation tissue, richly infiltrated with leucocytes and older hyalinized fibrous tissue. There are many lymph spaces which vary much in size and shape (Arachnoid?)”

In my opinion, this is exactly the same sort of structure as that encountered in Case VII—namely, an unabsorbed “rest” derived from the walls of the neural groove. In this case it was found at the extreme end of the cord instead of in the mid-dorsal region, and more than likely was the filum terminale still canalized.

CASE XI—St. Mary's Hospital, Reg. No. 281359, admitted April 3, 1928. A girl baby, well formed except for an abnormality in the lower part of mid-line of back, which consists of two portions, an upper hemispherical portion raised up to the extent of three-quarters of an inch and being about one and one-half inches in diameter. Attached to this and extending down from it, is a V-shaped trough, base formed by the above-mentioned tumor and apex extending to within two inches of anus. The V-shaped portion continues up and ends in a depression or dimple on the lower half of the tumor. This depressed, triangular area is red and glistening, looks like a congested mucous membrane, and from it is discharging clear fluid. The tumor is bluish-white. Its covering is a thin pellicle, semi-translucent. It becomes tense when the baby cries, also, the fluid flows more freely from the area when the baby cries. Between the tip of the reddish, triangular area and the anus, there is a deep depression (dimple) in the mid-line. The baby moves all of its limbs normally. There is no anal reflex. The baby voids urine from time to time, and although the anus has a loose feel, the bowel moves at intervals of perhaps three or four hours.

*Operation*—April 3, 1928. The day before operation, the part was painted every three hours with 2 per cent mercurochrome and kept covered with sterile gauze which was not allowed to become soiled. The preparation for operation consisted in painting the field with half-strength tincture of iodine. This was removed with alcohol. Iodine was not applied to the raw surface but 2 per cent mercurochrome was used instead. Then with a sharp knife, while the baby was held in the head-down position, beginning at the highest point of the raw area, the surface of the raw area was pared away under a stream of sterile saline. A very thin area was removed as is sometimes done in preparation for a skin graft. The tumor was incised and its interior inspected. It contained cerebrospinal fluid which escaped, when a mass could be seen apparently com-

was kept in the head-down position, but when cerebrospinal fluid no longer discharged, it was lowered to normal and lay on either side or abdomen

A partial post-mortem was obtained and revealed a diffuse, foul-smelling general peritonitis, the cause of which was not determined, but there was a distended bladder with gangrenous cystitis, and at one point the bladder wall was so thin that fibrin was laid down on the peritoneum at this point (posterior superior surface) Cultures were made but were lost on the way to the laboratory

CASE XII—St Mary's Infirmary, Reg No 63201, admitted June 4, 1928 A girl baby, ten months old Since birth the feet have been "clubbed" (varus), and baby has not moved her legs properly The child seems normal mentally The head is large The eye movements are normal and "the fundi show slight venous engorgement, and the disc edges are not clear" (Doctor Hardesty, ophthalmologist) The child can flex thighs on the abdomen Asleep, she lies on the right side with thighs almost at a right angle with the body, and knees in extension She can slowly move the right knee and foot slightly, but the whole left lower limb is paralyzed Response to pin prick and light touch is negative in the left leg and thigh, and seems less than normal in the right The sphincters are incontinent The anus gapes The baby's color is good, and it is well nourished There is a tumor, somewhat hemispherical, in the mid-line of the back in the mid-lumbar region It is about 5 centimetres by 5 centimetres, and is elevated about  $\frac{3}{4}$  centimetre Its surface looks like scar tissue, and is much furrowed The skin covering the summit is bluish and thin-looking The tumor has a lumpy feel, is compressible, but not reducible, becomes tense when the child cries, but does not pulsate A few coarse hairs are seen around its base An X-ray of the spine reveals a defect in the third and fourth lumbar vertebral arches There is a slight enlargement of the skull and convolutional impressions are deepened The other three children in the family are healthy The Wassermann (cerebrospinal fluid) is positive

*Operation*—June 4, 1928 A transverse excision removing an ellipse of skin with the tumor in the centre (See Fig 2) The pedicle of the sac was left long enough so that its edges could be approximated in a vertical suture The pedicle is thick and fibrous, and is about one inch in vertical, and slightly less in transverse diameter The sac contains clear fluid and a fibrous, cord-like structure—*filum terminale*?—issues from the canal and joins the roof of the sac in the mid-line below the centre of the summit Neither cord nor nerves were seen There was a quantity of peculiar, fibro-fatty tissue outside the pedicle The sac was cut away and the opening was closed by suturing the pedicle edges together vertically and then two flaps were raised from the lumbar aponeurosis, and turned over backward, the edge of one made to overlap that of the other The skin and subcutaneous tissue closed in the usual way by sliding down a flap from above The child made an uneventful recovery, and was discharged July 5, 1928

Present condition unknown

*Comment*—This child seemed to acquire more use of its legs after the operation, but I could not be entirely sure whether the movements were voluntary or reflex There was no recovery in the sphincters The mentality remained bright, and the child seemed quite well in other respects

#### SUMMARY

The records of all the author's cases up to 1929 are given—twelve cases There was one operative death(?) The child developed cystitis and peritonitis and died on the fourteenth day

The ages varied from sixteen hours to seven months There were seven females and five males

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prevention or treatment of septic processes because the innumerable bacteriological tests at our disposal are all subject to criticism, hence the reports are confusing and contradicting. Practically speaking, the only method to judge an antiseptic, after its bactericidal action has been ascertained in preliminary antiseptic and toxicity tests, is to evaluate the clinical results obtained and to compare them with results observed after use of other known disinfectants.

The fact that new antiseptics and germicidals make their appearance in the literature and on the market serves as best proof that most of the substances in general use fall short of the ideal in their therapeutic action. The popularity of some of the newer antiseptics is not based entirely upon their merits but is due partially to the wide publicity and undiscerning enthusiastic reports.

On the other hand, some valuable old antiseptics have been overlooked or fallen into misuse either because they have not been made the subject of extensive clinical studies or because they did not represent products of high commercial value. One of the most powerful among such antiseptics is brilliant green. The bacteriostatic action of certain dyes on bacteria was observed as early as 1887. Browning, *et al*<sup>3</sup> recommended the use of brilliant green in 1917, they found that the substance is particularly destructive to the cocci group but toward bacterium coli its bactericidal value is considerably lower. Krumwiede and Pratt<sup>4</sup> found that the inhibition of growth by brilliant green has been most evident among the Gram-positive bacteria, the paratyphoid enteritidis types are more resistant. Ligat<sup>5</sup> reported very satisfactory results with brilliant green. Peterson<sup>6</sup> studied the comparative merits of various antiseptics by recording their inhibiting effect upon the yeast-sugar mixture. The method consists in determining the smallest quantity of drug that will prevent the formation of gas in a yeast-sugar mixture of definite strength during a period of one hour. Whereas the inhibitory amount of metaphen in grams was 0.0017 and that of mercurochrome 0.065, the amount of gentian violet was only 0.0039, crystal violet 0.0024 and methyl violet 0.0051. These figures show that the above-mentioned aniline dyes possess a much stronger inhibitory power than mercurochrome and compare very favorably with metaphen. Another dye, however, is still superior to these aniline dyes as far as bactericidal action is concerned and this is brilliant green as shown by the experiments carried out by Norton and Davis<sup>7</sup> who determined the bacteriostatic action of dyes on streptococcus viridans and pneumococci. They state that brilliant green is the most active dye they found, as evidenced from the following part of their protocol:

Dye	Slightest dilution giving complete inhibition
Brilliant green	200,000
Gentian violet	40,000
Methylene blue	25,000
Methyl violet	10,000

According to their statement to have a marked bacteriostatic action, a dye must contain three benzol rings and two or more amino-groups in which the

No infections were observed which could be ascribed to the use of brilliant green. In one case a stitch abscess occurred which could be traced to contaminated catgut. Not in a single case in the series of 111 were there any indications of irritation of the skin, even when wet compresses had to be applied afterward. The use of brilliant green should be of special value in the pre-operative preparation of the skin for thyroidectomies where absorption of the tincture of iodine is feared. A 0.5 per cent solution was used on mucous membranes for hemorrhoidectomies, vaginal repairs, suturing of lacerated lips and similar conditions.

2 *Prophylactic Treatment* of potentially infected wounds and abrasions including minor injuries as well as extensive lacerations which came under treatment a very short time after injury and where no clinical signs of infection were yet present. There is no positive criterion to judge the efficiency of an antiseptic in such conditions and in forming an opinion one is guided by impressions rather than by definite figures. An opportunity presented itself, however, in a case of laceration of several fingers to investigate the comparative value of metaphen, mercurochrome and brilliant green. All seven injured fingers presented approximately the same degree of injury of soft parts and were equally contaminated with dirt and machine oil. The two wounds treated with metaphen showed no signs of infection and produced granulations of a pale pink color, the healing process was fairly rapid, three fingers treated with mercurochrome produced pus and showed brownish granulations of moderate size with very slow healing tendencies, in two fingers treated with brilliant green a rapid formation of exuberant, bright-red granulations could be observed which led to a scar formation more quickly than in the other fingers. Of course, such an experiment is not conclusive as to the relative value of various antiseptics as it may be argued that the degree of infection of each injured finger could not be exactly determined, nevertheless the striking results are in line with experiments of Browning, *et al*,<sup>3</sup> who also observed in a large number of cases that brilliant green stimulates the formation of richly vascularized red granulations while with flavine the granulations were not so bulky and of pale color. No indications of tissue damage or irritation could be observed.

B *Therapeutic Treatment*—This category comprises 123 cases which already exhibited manifest infection when they presented themselves for treatment. This group comprises such spastic conditions as abscesses located in various parts of the body, including Bartholin's abscesses and post-operative stitch abscesses, acute suppurative bursitis, acute suppurative lymphadenitis, boils, carbuncles, phlegmons, cellulitis, fistulae resulting from osteomyelitis. In addition to the painting of the skin with brilliant green solution before the incision was made, the solution was also instilled into the wounds at each dressing. In a number of cases this treatment was supplemented by bathing the infected part in a warm aqueous solution of brilliant green 1:2000 and compresses of an aqueous solution 1:1000. In ischio-rectal and perianal abscesses the results appeared to be superior to mercuro-



very cheap. The impression was gained that in many instances the substance was superior to other antiseptics in common use. These findings justify further clinical investigations as to the value of brilliant green and suggest the desirability of laboratory experiments in order to evaluate it as a general antiseptic.

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of the face. Metastases to the parotid gland and temporal region had occurred. Biopsy of a gland in the temporal region had been done, and at the time seen the field was slightly infected. Because of the presence of tumor in the operative field and also because of the presence of infection it was thought advisable to section the posterior root of the trigeminal nerve through the posterior fossa. This was carried out under novocaine and colonic ether anesthesia. There was some difficulty in exposing the trigeminal dorsal root owing to the fact that a large petrosal nerve lay directly over it and a small artery to the side of it. The artery was coagulated and divided. It was then possible to slip a hook beneath the vein and avulse the posterior root without damaging the motor division or tearing the petrosal vein. The patient had complete anesthesia in the distribution of the fifth nerve. (Fig 1 and Fig 2)

CASE III—*Carcinoma of the jaw with cervical metastases. Section of the posterior root of trigeminal nerve through the posterior fossa in order to combine cervical dorsal rhizotomy with section of the root of the fifth nerve.* G. G., hospital No 26,597, a



FIG 1

FIG 1—Case II. Basal cell carcinoma of face. Metastases to temporal region and parotid gland which base became infected following biopsy.

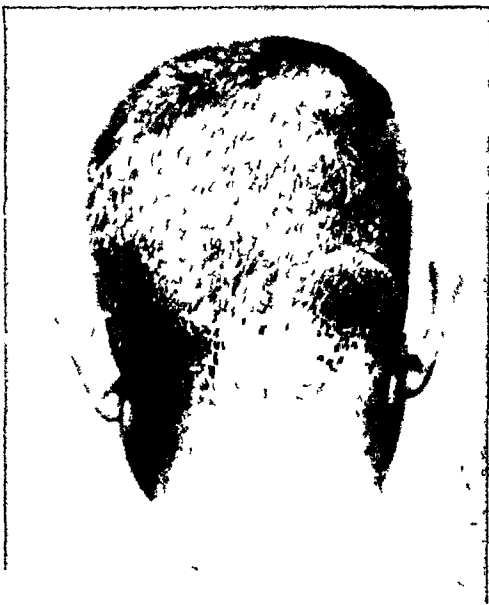


FIG 2

FIG 2—Case II. Type of incision used for unilateral cerebellar exposure and section of dorsal root of trigeminal nerve via posterior fossa.

forty-seven-year-old man, was transferred to the neurosurgical service because of severe pain from carcinoma of the right jaw with metastases to the floor of the mouth and cervical lymph-nodes. When first seen most of the pain was largely in the region of cervical metastases. A section of the cervical nerves as they appeared along the posterior border of the sternocleidomastoid muscle was done rather than an intradural dorsal-root section, because of his poor general condition. At the same time a ligation of the external carotid artery was carried out because of the danger of hemorrhage from ulcerations within the oral cavity. The patient obtained considerable relief from pain for about six months and was able to eat and sleep moderately well. At the end of this time, however, he had a recurrence of the pain both in the distribution of the cervical nerves and of the right trigeminal nerve. Opiates by this time had proven to be of little use and some more radical measure for relief of pain seemed warranted. Under colonic ether and local anesthesia, the right trigeminal nerve was exposed through the posterior fossa. There were two good-sized branches of the petrosal veins lying over

root, each associated with fairly profuse bleeding, the wound was closed. Several days later the posterior root of the fifth nerve was divided through the posterior fossa. The patient succumbed some six days later. Autopsy revealed the presence of a small carcinoma of the sphenoid sinus with extension to the pituitary gland, sphenoid bone, left Gasserian ganglion, and the dura mater at the base of the skull (Fig 3). He also had moderate bilateral bronchopneumonia, arteriosclerotic kidney, healed pulmonary tuberculosis, and chronic, adhesive pleuritis. Changes in bone commonly associated with Paget's disease were everywhere evident.

*CASE V—Trigeminal neuralgia—major. Section of posterior root of trigeminal nerve through posterior fossa because of dense adhesions between dura mater and Gasserian ganglion.* R. H., a forty-one-year-old man, was referred to the hospital because of severe trigeminal neuralgia of some ten years' duration. He had had nine or ten "deep alcohol injections," only two of which had given any lasting benefit.

*Operation.*—An attempted section of the dorsal root of the trigeminal nerve through the temporal fossa was made with the patient in the sitting posture. The middle meningeal artery was divided without difficulty. From this point on the dissection to uncover the dorsal root was extremely difficult. The dura was leather-like and so densely adherent to surrounding structures that it could not be elevated from over the dorsal root. The mandibular division of the ganglion and dura over it seemed fused. The ophthalmic division of the ganglion was then exposed and attempt made to uncover enough of the ganglion itself to either inject it or extirpate it. This also proved impossible. Presumably the previous stray alcohol injections had set up a profuse connective tissue reaction about the dura and surrounding structures.

Two days later the posterior root of the trigeminal nerve was exposed through the posterior fossa. The arachnoid about the nerve was much thickened and adherent to surrounding structures. Several fair-sized radicles of the petrosal veins gave troublesome bleeding and it was only after a long tedious procedure that the dorsal root was finally divided. The patient has had complete relief of pain but has had some persistent ataxia of one arm, presumably due to damage to the cerebellum in exposing the dorsal root and controlling bleeding.

The operative procedure has varied greatly in its technical difficulties. In three of the reported cases the trigeminal dorsal root was sectioned with comparative ease. In one case it was necessary to electrocoagulate the root along with a branch of the petrosal vein. The root could not be divided without a great likelihood of tearing the vein. On the other hand, complete anaesthesia and relief of pain followed such a procedure. In one case serious bleeding from a torn petrosal vein occurred and was controlled only with difficulty. Evidence of slight but permanent damage of the cerebellar lobe has resulted. In none of the cases has there resulted any injury to an adjoining nerve. The operation has been performed on five other patients where the dorsal root could have been sectioned through the temporal fossa. In two of these cases the root was only partially sectioned. In both of these cases the pain has been completely relieved. Sensory examination following this is in accord with that described by Dandy, *loc. cit.*, there was a preservation of normal sensation over the distribution of the trigeminal nerve except for a small area about the upper lip in one instance and about the lower lip in another. The impression gained from these ten cases is that the operation is a procedure of considerably greater magnitude and risk than that through the temporal fossa. In spite of this, familiarity with the operation would

## PENETRATING WOUNDS OF THE ABDOMEN\*

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WE HAVE reviewed the records of 220 cases of penetrating wounds of the abdomen admitted to the Pennsylvania Hospital during the years 1909 to 1930 inclusive, and for the privilege of reporting them we are much indebted to Drs John H Gibbon and Charles F Mitchell, surgeons-in-chief to the hospital, and to the former chiefs upon whose services they were admitted. We have not included in this series any cases with penetrating wounds other than those resulting from stab and gunshot injuries. We are considering the two groups separately because the stab wounds, as a group, are less serious than the gunshot cases for the reason that, in the latter, there is more hæmorrhage and more extensive visceral injury.

In this series, about the usual ratio of danger of the gunshot over the stab injuries was maintained, that is, a little more than 2 to 1. The operative mortality in civil life seems to have been established around the 50 per cent level for gunshot wounds and about 25 per cent for the stab injuries, with a considerably higher total rate for both groups. In the gunshot cases, Wallace, reporting on 1200 cases from the British Expeditionary Force, showed an operative mortality of 53.9 per cent, and a total mortality including non-operative cases of 60.2 per cent. Lockwood Kennedy, *et al* in military service, reported on 500 cases with an operative mortality of 51.97 per cent. In 1902 Fcner reported on 152 cases of gunshot wounds from the Charity Hospital New Orleans 96 of which suffered visceral injury with 71 deaths (74 per cent). Bivings, in 66 cases operated upon reported a mortality of 60.6 per cent. McKeirthen's mortality on 56 gunshot cases was 44.6 per cent, and on 13 stab cases 30.7 per cent.

The experience of the Charity Hospital in New Orleans in these injuries seems to have been greater than that of any other institution, and they have appointed, under the direction of Doctor Matas, a special committee for the study of these cases. Miller's report on a personal experience in 46 cases operated upon there with 23 recoveries, and a paper by Loria dealing with "visceral injuries in gunshot wounds of the abdomen" are the latest communications from this institution. Mason, in his last report, analyzed 127 cases, stressing the influence of hæmorrhage on mortality, and has divided his series into a large and small hæmorrhage group regardless of visceral injury showing a mortality of 87.2 per cent in the large hæmorrhage series, and 36.1 per cent in the small hæmorrhage series. He urges strongly the

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findings—Intestine protruding, slight hæmorrhage Operation—Exploratory laparotomy, irrigation N S S, drainage Days in hospital—Twenty-one

CASE III—White man, twenty-three years old Operation, hours after injury—? Location of wound—Lower right abdomen, anterior Operative findings—Penetrating wound, slight hæmorrhage Operation—Exploratory laparotomy, no drainage Days in hospital—Eighteen

CASE IV—White man, forty-seven years old Operation, hours after injury—One and one-half Location of wound—Upper left abdomen, anterior Operative findings—Laceration of mesentery, slight hæmorrhage Operation—Laparotomy, ligation, no drainage, irrigation N S S Days in hospital—Twenty

CASE V—White man, sixteen years old Operation, hours after injury—? Location of wound—Lower left abdomen, anterior Operative findings—Four perforations ileum, laceration of mesentery, severe hæmorrhage Operation—Enterorrhaphy, irrigation N S S, drainage Days in hospital—Thirty-two

CASE VI—White man, thirty-one years old Operation, hours after injury—One and one-quarter Location of wound—Upper left abdomen, from back Operative findings—Wound of spleen, diaphragm, pleura, slight hæmorrhage Operation—Laparotomy, drainage Complications—Pulmonary collapse Days in hospital—Twelve

CASE VII—Colored man, fifty years old Operation, hours after injury—Two Location of wound—Upper left abdomen, anterior Operative findings—Two perforations stomach, slight hæmorrhage Operation—Gastrorrhaphy, no drainage Complications—Local peritonitis Days in hospital—Thirty

CASE VIII—Colored man, thirty-six years old Operation, hours after injury—Three Location of wound—Upper mid-abdomen Operative findings—Wound of stomach, evisceration of stomach and omentum, moderate hæmorrhage Operation—Gastrorrhaphy Days in hospital—Thirteen

CASE IX—White man, twenty years old Operation, hours after injury—Four and one-half Location of wound—Upper left abdomen Operative findings—One perforation of small intestine, laceration mesentery Operation—Enterorrhaphy suture, no drainage Days in hospital—Thirteen

CASE X—White man, twenty-two years old Operation, hours after injury—Three Location of wound—Upper left abdomen Operative findings—Wound of stomach, slight hæmorrhage Operation—Gastrorrhaphy, no drainage Days in hospital—Thirty

CASE XI—White woman, thirty-eight years old Operation, hours after injury—? Location of wound—Left lower abdomen Operative findings—Penetrating wound, severe hæmorrhage, external wound Operation—Exploratory laparotomy, no drainage Days in hospital—Eighteen

CASE XII—White man, twenty-one years old Operation, hours after injury—? Location of wound—Upper left abdomen, anterior, multiple Operative findings—Wound of stomach, diaphragm, pleura Operation—Gastrorrhaphy, suture diaphragm, drainage Days in hospital—Twenty

CASE XIII—White man, twenty-two years old Operation, hours after injury—? Location of wound—Lower left abdomen Operative findings—Penetrating wound Operation—Exploratory laparotomy, no drainage Complications—Partial obstruction fifth day Days in hospital—Seventeen

CASE XIV—White man, twenty-two years old Operation, hours after injury—Eighteen Location of wound—Upper left abdomen, anterior Operative findings—Wound of diaphragm Operation—Exploratory laparotomy, suture diaphragm, no drainage Days in hospital—Fifteen

CASE XV—White man, twenty-five years old Operation, hours after injury—One Location of wound—Upper left abdomen, lateral Operative findings—Laceration of

findings—Penetrating wound, laceration of omentum, omentum protruding, moderate hæmorrhage Operation—Exploratory laparotomy, suture, ligation, no drainage Days in hospital—Fourteen

CASE XXIX—Colored man, forty-two years old Operation, hours after injury—Two and one-half Location of wound—Lower left abdomen, anterior Operative findings—One perforation small intestine, moderate hæmorrhage Operation—Enterorrhaphy, suture, drainage Days in hospital—Seventeen

CASE XXX—White man, twenty-six years old Operation, hours after injury—Two Location of wound—Upper right abdomen, anterior Operative findings—Penetrating wound Operation—Exploratory laparotomy, no drainage Complications—Infection of wound Days in hospital—Twenty

CASE XXXI—Colored man, forty-nine years old Operation, hours after injury—Two and one-half Location of wound—Anterior abdomen Operative findings—Penetrating wound, severe hæmorrhage from omentum Operation—Exploratory laparotomy, ligation, no drainage Days in hospital—Nineteen

CASE XXXII—Colored man, thirty-six years old Operation, hours after injury—One Location of wound—Upper left abdomen, posterior lateral Operative findings—Small intestine protruding through penetrating wound Operation—Exploratory laparotomy no drainage Days in hospital—Nineteen

CASE XXXIII—White man, thirty-five years old Operation, hours after injury—Three-quarters Location of wound—Upper left abdomen, anterior Operative findings—Laceration of mesentery of small intestine Operation—Exploratory laparotomy, suture no drainage Days in hospital—Fourteen

CASE XXXIV—White man, thirty-eight years old Operation, hours after injury—Two Location of wound—Upper left abdomen, anterior Operative findings—Severance of hypogastric vein, wound of mesentery, descending colon Operation—Exploratory laparotomy, ligation Days in hospital—Eighteen

CASE XXXV—White man, thirty-nine years old Operation, hours after injury—One Location of wound—Upper left abdomen, anterior Operative findings—Perforation of jejunum, laceration of mesentery, hæmorrhage Operation—Enterorrhaphy, suture no drainage Days in hospital—Eighteen

CASE XXXVI—Colored man, twenty-six years old Operation, hours after injury—Two Location of wound—Upper left abdomen, anterior Operative findings—Penetrating wound of liver moderate hæmorrhage Operation—Laparotomy, suture of liver no drainage Days in hospital—Fourteen

CASE XXXVII—Colored man, ? years old Operation, hours after injury—One Location of wound—Lower right abdomen, anterior Operative findings—Penetrating wound Operation—Exploratory laparotomy, no drainage Days in hospital—Sixteen

CASE XXXVIII—Colored woman, fifty years old Operation, hours after injury—Three and one-half Location of wound—Left lateral abdomen (flank) Operative findings—Penetrating wound, laceration mesentery, descending colon Operation—Exploratory laparotomy, ligation, drainage Days in hospital—Thirty

CASE XXXIX—Colored man, eighteen years old Operation, hours after injury—One Location of wound—Lower right abdomen, anterior Operative findings—Omentum protruding Operation—Omentum excised no drainage Days in hospital—Thirteen

CASE XL—Colored man, thirty-five years old Operation, hours after injury—Fourteen Location of wound—Lower left abdomen anterior Operative findings—Penetrating wound, slight hæmorrhage Operation—Exploratory laparotomy, drainage Complications—Local peritonitis Days in hospital—Fourteen

CASE XLI—Colored man thirty-five years old Operation, hours after injury—One Location of wound—Upper left abdomen, anterior Operative findings—Pene-

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CASE LIV—Colored man, thirty-four years old Operation, hours after injury—Two Location of wound—Upper left abdomen, anterior Operative findings—Laceration of gall-bladder, omentum protruding, slight hemorrhage Operation—Exploratory laparotomy, suture ligation with drainage Days in hospital—Eighteen

CASE LV—Colored man, thirty-nine years old Operation, hours after injury—Five Location of wound—Upper left abdomen, lateral Operative findings—Penetrating wound, severe hemorrhage, laceration gastrocolic omentum, omentum protruding Operation—Exploratory laparotomy, ligation with drainage, reinfusion 500 cubic centimetres of blood Complications—Wound infection Days in hospital—Twenty-three

CASE LVI—Colored man, twenty-two years old Operation, hours after injury—One-half Location of wound—Lower left abdomen, anterior Operative findings—One perforation small intestine, slight hemorrhage, omentum protruding Operation—Enterorrhaphy, no drainage Days in hospital—Eleven

CASE LVII—Colored female, twenty-eight years old Operation, hours after injury—Ten Location of wound—Upper left abdomen, from back Operative findings—One perforation large intestine, descending colon Operation—Enterorrhaphy, with drainage Complications—Wound infection Days in hospital—Twenty-three

CASE LVIII—Colored man, twenty-nine years old Operation, hours after injury—Two Location of wound—Upper left abdomen, posterior Operative findings—Laceration of spleen (slight) and diaphragm, slight hemorrhage, omentum protruding Operation—Exploratory laparotomy, suture with drainage Complications—Wound rupture ninth day, resutured Days in hospital—Thirty-one

CASE LIX—Colored man, thirty-eight years old Operation, hours after injury—Four Location of wound—Upper left abdomen, anterior Operative findings—Wound of liver, pancreas (slight), severe hemorrhage Operation—Exploratory laparotomy, packing with drainage Days in hospital—Seventeen

CASE LX—Colored man, twenty-five years old Operation, hours after injury—Twelve Location of wound—Upper left abdomen, anterior Operative findings—One perforation of anterior wall of stomach Operation—Gastrorrhaphy, suture with drainage Complications—Wound infection Days in hospital—Twenty-three

### *Stab-wound Injuries—No Operation—Recovery*

CASE I—White man, thirty-five years old Multiple stab wounds, penetrating, but probably no perforations Refused operation Left hospital in two days with signs of peritonitis still present Readmitted to hospital three times during the next month without abdominal symptoms, but infection still present in shoulder wounds

CASE II—Colored man, thirty-six years old Single stab wound, penetrating but probably no visceral injury Refused operation Apparently had local peritonitis which subsided Left hospital in five days, earlier than advised, but in good condition

CASE III—Colored man, thirty-two years old Multiple stab wounds Penetrating wound right thoracic cavity, surgical emphysema (no effusion of consequence), penetrating wound upper abdomen without visceral injury, no peritonitis, no infection of wounds, no complications Left the hospital in eleven days

### *Stab-wound Injuries—Operation—Death*

CASE I—Colored man, twenty-four years old Operation, hours after injury—One and three-quarters Location of wound injury—Lower right abdomen, anterior Operative findings—Two perforations small intestine, two of large intestine, severe hemorrhage Operation—Enterorrhaphy, irrigation N S S, drainage Time and autopsy cause of death—Fourteen hours, hemorrhage, shock, early peritonitis

CASE II—Colored woman, fifty-seven years old Operation, hours after injury—Two Location of wound injury—Upper left abdomen Operative findings—Wound

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cause of death—Four hours, hæmorrhage, penetration right pleura, wound superior vena cava overlooked at operation

CASE XII—Colored man, thirty-five years old Operation, hours after injury—One and one-half Location of wound injury—Upper left abdomen, anterior Operative findings—Wound of stomach, severe hæmorrhage, second operation for rupture of wound with evisceration of intestines Operation—First operation, gastrorrhaphy, no drainage, second operation second day, wound repair, drainage Complications—Ruptured wound, general peritonitis Time and autopsy cause of death—Four days, general peritonitis

CASE XIII—White man, twenty-six years old Operation, hours after injury—One to two Location of wound injury—Left abdomen, anterior Operative findings—One perforation small intestine, injury to mesenteric border of ileum, severe hæmorrhage Operation—Enterorrhaphy, no drainage, second day after operation drained for peritonitis Complications—General peritonitis Time and autopsy cause of death—Two days, general peritonitis, fulminating

CASE XIV—White man, forty-four years old Operation, hours after injury—One and one-half Location of wound injury—Right abdomen, multiple of chest and body (17 wounds) Operative findings—One perforation of stomach, transverse colon, laceration of omentum, moderate hæmorrhage, wound of left lung Operation—Gastrorrhaphy, enterorrhaphy, repair omentum, drainage Complications—Delirium tremens Time and autopsy cause of death—Seven days, peritonitis, wounds of liver and left kidney overlooked

CASE XV—Colored man, sixty years old Operation, hours after injury—One Location of wound injury—Upper and lower right abdomen, anterior (multiple) Operative findings—Laceration of liver, penetrating wounds, moderate hæmorrhage Operation—Laparotomy, packing liver wound (too tight) Complications—Pulmonary œdema, bilary fistula Time and autopsy cause of death—Seven days, pneumonia infection of liver wound, subphrenic abscess

CASE XVI—Colored woman, twenty-five years old Operation, hours after injury—Four and one-half Location of wound injury—Upper left abdomen, anterior Operative findings—Six perforations jejunum, one of transverse colon, moderate hæmorrhage Operation—Enterorrhaphy, ligation, suture, drainage Complications—Local peritonitis, pulmonary œdema Time and autopsy cause of death—Four days, hæmorrhage, shock, advanced pulmonary tuberculosis contributing cause

CASE XVII—White man fifty-three years old Operation, hours after injury—Eighteen Location of wound injury—Lower left abdomen, anterior, multiple Operative findings—Multiple perforations small intestine and mesentery, one of mesosigmoid, moderate hæmorrhage Operation—Resection of fifteen inches ileum and lateral anastomosis, drainage Time and autopsy cause of death—Four days, septic peritonitis

### *Stab-wound Injuries—No operation—Death*

CASE I—White man, forty years old Multiple stab wounds of heart and abdomen, penetrating Died two minutes after admission No autopsy

CASE II—White man, forty-two years old Single stab wound left upper abdomen Had generalized œdema with cardiac decompensation Suicide Died in twenty hours No autopsy

CASE III—Colored man, ? years old Single stab wound left upper abdomen Died immediately after admission Autopsy showed clot in pericardium causing compression of heart, right side of right ventricle penetrated

CASE IV—Colored man, twenty-three years old Single stab wound epigastrium Signs of severe hæmorrhage, omentum protruding Died in twenty minutes No autopsy



seventh day In one case leakage occurred after repair of six perforations of the colon Death resulted on the fourth day from peritonitis

<i>Gunshot Wounds</i>			
Total gunshot-wound cases	136	{ recoveries	61
		{ deaths	75
Cases operated upon	114	{ recoveries	59
		{ deaths	55
Cases not operated upon	22	{ recoveries	2
		{ deaths	20

A total mortality of 55.14 per cent is shown in this group and an operative mortality of 48.2 per cent In the group of operative recoveries of which there were 59, hæmorrhage was severe in 27, moderate in 12, slight in 12, and no note as to hæmorrhage in 8 cases In 21 cases visceral injuries were single, and in 32 they were multiple

## GROUP II

### *Gunshot Wound Injuries—Operation—Recovery*

CASE I—Colored man, forty-two years old Operation, hours after injury—Two Location of wound—Upper left abdomen anterior Operative findings—Wound of liver, severe hæmorrhage Operation—Packing wound, drainage Days in hospital—Thirty-four

CASE II—Colored man, twenty-seven years old Operation, hours after injury—One and one-quarter Location of wound—Lower left abdomen, anterior Operative findings—Two perforations sigmoid, moderate hæmorrhage Operation—Enterorrhaphy, suture, drainage Complications—Wound infection Days in hospital—Eighteen

CASE III—Colored man twenty-seven years old Operation, hours after injury—Three Location of wound—Lower left abdomen anterior Operative findings—Wound of bladder, slight hæmorrhage Operation—Marsupialization with drainage Days in hospital—Fifty-nine

CASE IV—White man, seventy-three years old Operation, hours after injury—One and one-half Location of wound—Upper left abdomen, anterior Operative findings—Perforation of stomach severe hæmorrhage Operation—Gastrorrhaphy, suture, drainage Days in hospital—Fifty-nine

CASE V—White man, nineteen years old Operation, hours after injury—One and one half Location of wound—Mid-abdomen Operative findings—Two perforations jejunum severe hæmorrhage Operation—Enterorrhaphy, suture, packing Complications—Pneumonia effusion Days in hospital—Forty

CASE VI—White woman, sixteen years old Operation hours after injury—? Location of wound—Right upper abdomen Operative findings—Wound of liver severe hæmorrhage Operation—Packing wound Days in hospital—Fourteen

CASE VII—Colored man, twenty-six years old Operation, hours after injury—Three and one-half Location of wound—Lower left abdomen, posterior Operative findings—Wound right ureter Operation—Drainage Complications—Urinary fistula, posterior healed spontaneously Days in hospital—Forty-four

CASE VIII—Colored woman twenty-five years old Operation hours after injury—Two Location of wound—Lower left abdomen, anterior Operative findings—Wound of liver, severe hæmorrhage Operation—Packing wound drainage Complications—Liver abscess? drainage, fever five weeks Days in hospital—Seventy

CASE XXII—White man, twenty-three years old Operation, hours after injury — Two and three-quarters Location of wound—Lower abdomen, anterior Operative findings—Injury to veins in pelvis, severe hæmorrhage Operation—Packing in pelvis, drainage Days in hospital—Seventeen

CASE XXIII—White man, eighteen years old Operation, hours after injury—Twenty-six Location of wound—Upper right abdomen Operative findings—Two perforations small intestine, severe hæmorrhage, laceration mesentery Operation—Enterorrhaphy, drainage, suture Complications—Influenza Days in hospital—Thirty-one

CASE XXIV—Colored man, thirty years old Operation, hours after injury—Two Location of wound—Lower left abdomen, anterior Operative findings—Large hæmatoma in spermatic cord, moderate hæmorrhage Operation—Drainage Days in hospital—Fourteen

CASE XXV—White man, thirty-eight years old Operation, hours after injury—One Location of wound Lower abdomen Operative findings—Thirteen perforations small intestine, one of bladder, moderate hæmorrhage Operation—Enterorrhaphy, lateral anastomosis without resection, suture, drainage Days in hospital—Forty-four

CASE XXVI—Colored man, twenty-five years old Operation, hours after injury—One and one-half Location of wound—Upper right abdomen, lateral Operative findings—Wound of liver and diaphragm, severe hæmorrhage Operation—Packing liver wound, drainage Complications—Wound infection Days in hospital—Twenty-three

CASE XXVII—White man, nineteen years old Operation, hours after injury—Two Location of wound—Lower abdomen from back Operative findings—Laceration gastro-colic omentum, injury lumbar plexus, severe hæmorrhage Operation—Suture, no drainage Complications—Paralysis left foot, wound infection, general peritonitis Days in hospital—Forty-three

CASE XXVIII—White man, thirty-four years old Operation, hours after injury—One and three-quarters Location of wound—Upper right abdomen from back Operative findings—Wound right lobe liver, right kidney, severe hæmorrhage Operation—Packing, drainage, suture Days in hospital—Twenty

CASE XXIX—White man, twenty-two years old Operation, hours after injury—Two Location of wound—Upper right, left abdomen, anterior Operative findings—Wound of liver and stomach, severe hæmorrhage Operation—Gastrorrhaphy, packing Days in hospital—Twenty-five

CASE XXX—Colored man, forty-one years old Operation, hours after injury—? Location of wound—Lower left abdomen, anterior Operative findings—Four perforations small intestine, thrombosis of veins, mesentery Operation—Resection with lateral anastomosis, wound resutured sixth day, drainage Complications—General peritonitis Days in hospital—Thirty-four

CASE XXXI—White girl, twelve years old Operation, hours after injury—One Location of wound—Upper abdomen Operative findings—Wound of liver, spleen, stomach Operation—Suture, gauze pack, gastrorrhaphy, drainage Days in hospital—Twenty-six

CASE XXXII—White man, twenty-seven years old Operation hours after injury—One and one-half Location of wound—Upper abdomen, posterior, left side Operative findings—Upper edge of spleen nicked, slight hæmorrhage Operation—Packing vaseline gauze, drainage Complications—Pleurisy Days in hospital—Thirteen

CASE XXXIII—White man, thirty-two years old Operation, hours after injury—One Location of wound—Lower left abdomen, anterior Operative findings—Six perforations small intestine, one of sigmoid, several perforations omentum, severe hæmorrhage Operation—Enterorrhaphy, ligation, resection ileum, end-to-end anastomosis no drainage Complications—General peritonitis, wound infections Days in hospital—Twenty-eight

CASE XXXIV—White man, eighteen years old Operation, hours after injury—?

jagged wound of liver, severe hemorrhage Operation—Packing wound, drainage  
Complications—Wound infection, drained bile Days in hospital—Thirty

CASE XLVII—White man, twenty-seven years old Operation, hours after injury—<sup>2</sup> Location of wound—Upper right and left abdomen Operative findings—Wound of left kidney, retroperitoneal hematoma, moderate hemorrhage Operation—Exploratory laparotomy, suture of kidney Days in hospital—Twenty-four

CASE XLVIII—Colored man, thirty-one years old Operation, hours after injury—One and one-quarter Location of wound—Upper right abdomen, anterior Operative findings—Wound of liver, moderate hemorrhage Operation—Packing, drainage, reinfusion or replacement of 300 cubic centimetres blood Complications—Pneumonia Days in hospital—Forty

CASE XLIX—White man, twenty-nine years old Operation, hours after injury—One Location of wound—Right lateral abdomen, flank Operative findings—Nine perforations ileum and jejunum, injury to mesentery of ascending colon severe hemorrhage Operation—Enterorrhaphy, suture, drainage Complications—Fracture head of left humerus Days in hospital—Twenty-five

CASE L—Colored woman, thirty years old Operation, hours after injury—Ten (refused early operation) Location of wound—Lower right abdomen, anterior Operative findings—No visceral injury, slight hemorrhage Operation—Exploratory laparotomy, X-ray disclosed bullet lodged in uterus Days in hospital—Twenty-three

CASE LI—Colored man, twenty-two years old Operation, hours after injury—<sup>2</sup> Location of wound—Upper right abdomen Operative findings—Ten perforations of small intestine, severe hemorrhage, injury to mesentery Operation—Enterorrhaphy Days in hospital—Twenty-six

CASE LII—White man, nineteen years old Operation, hours after injury—One Location of wound—Upper right abdomen, lateral Operative findings—Wound of liver, two perforations of stomach, injury to mesentery, moderate hemorrhage Operation—Gastrorrhaphy, suture, packing liver wound, drainage Complications—Wound infection Days in hospital—Thirty-two

CASE LIII—White man, twenty-five years old Operation, hours after injury—Fourteen and one-half Location of wound—Upper right abdomen, anterior Operative findings—Wound of liver and diaphragm, severe hemorrhage Operation—Packing liver wound drainage, laparotomy Days in hospital—Twenty-two

CASE LIV—Colored woman, twenty-four years old Operation, hours after injury—Twenty-one Location of wound—Lower abdomen anterior Operative findings—Wound of bladder Operation—Exploratory laparotomy, suture, drainage Days in hospital—Forty-three

CASE LV—Colored man, twenty-three years old Operation, hours after injury—One and one-half Location of wound—Upper left abdomen anterior Operative findings—Nine perforations of small intestine, ileum, slight hemorrhage Operation—Enterorrhaphy drainage Days in hospital—Fourteen

CASE LVI—White boy, thirteen years old Operation, hours after injury—One and one-quarter Location of wound—Upper left abdomen, anterior Operative findings—Wound of liver contusions small intestines, two perforations transverse colon slight hemorrhage Operation—Enterorrhaphy, drainage, suture Days in hospital—Thirty

CASE LVII—White boy, eight years old Operation, hours after injury—One and one-quarter Location of wound—Upper abdomen, anterior Operative findings—Wound of liver, pancreas, two perforations of stomach, severe hemorrhage Operation—Gastrorrhaphy, pack liver wound drainage Days in hospital—Forty-four

CASE LVIII—White woman, twenty-six years old Operation hours after injury—Four and three-quarters Location of wound—Lower abdomen, posterior Operative findings—Two perforations small intestine, two of large intestine, slight hemorrhage,

tion—Local peritonitis Time and autopsy cause of death—Twenty-four days, subphrenic abscess, perforation of posterior wall of stomach and liver overlooked, sepsis

CASE VIII—Colored man, twenty-four years old Operation, hours after injury—Two Location of wound—Upper left abdomen, lateral Operative findings—Two perforations of stomach, two of small intestine, two of ascending colon, severe hæmorrhage Operation—Gastrorrhaphy, enterorrhaphy, suture, ligation, drainage Time and autopsy cause of death—Twelve hours, hæmorrhage and shock

CASE IX—White woman, forty years old Operation, hours after injury—One and three-quarters Location of wound—Lower right abdomen, lateral Operative findings—Wound of liver, moderate hæmorrhage Operation—Exploratory laparotomy, suture Complication—Early peritonitis Time and autopsy cause of death—Two and one-half days hæmorrhage, peritonitis chronic nephritis

CASE X—Colored man, thirty-two years old Operation, hours after injury—Two Location of wound—Upper right abdomen, anterior Operative findings—Thirteen perforations small intestine two of large intestine, lacerations mesentery, moderate hæmorrhage Operation—Enterorrhaphy, suture, drainage, irrigation N S S Time and autopsy cause of death—Two and one-half days, hæmorrhage, peritonitis, chronic alcoholic nephritis

CASE XI—White man, thirty-two years old Operation, hours after injury—Two Location of wound—Upper right abdomen, lateral Operative findings—Perforating wound of liver, severe hæmorrhage, cavity filled with blood Operation—Exploratory laparotomy, packing, drainage Time and autopsy cause of death—Forty hours, profuse hæmorrhage shock, early peritonitis One perforation stomach, one of spleen, two of diaphragm overlooked

CASE XII—White man, thirty-five years old Operation, hours after injury—Two Location of wound—Upper right abdomen, anterior Operative findings—Eleven perforations of small intestine, severe hæmorrhage Operation—Enterorrhaphy, drainage Time and autopsy cause of death—Twenty-three hours, rapid peritonitis, hæmorrhage

CASE XIII—White man, fifty years old Operation, hours after injury—Three-quarters Location of wound—Upper right abdomen, anterior Operative findings—Wound of liver, two perforations stomach through pylorus, laceration of mesentery, wound of pancreas, severe hæmorrhage Operation—Gastrorrhaphy, packing, drainage Time and autopsy cause of death—Nine hours, hæmorrhage, shock

CASE XIV—Colored man, forty-five years old Operation, hours after injury—One Location of wound—Upper left abdomen, anterior Operative findings—Wound of liver and diaphragm, severe hæmorrhage, probable injury to spinal cord Operation—Exploratory laparotomy, packing, drainage Complications—Retention of urine, incontinence of feces, anesthesia and paralysis both legs to knee Time and autopsy cause of death—Sixteen days, peritonitis, urinary-tract sepsis, injury to pancreas overlooked

CASE XV—White woman, twenty-nine years old Operation, hours after injury—? Location of wound—Upper abdomen Operative findings—Eleven perforations to small intestine, injury to mesentery, severe hæmorrhage Operation—Enterorrhaphy, drainage Time and autopsy cause of death—Fourteen hours, hæmorrhage, shock

CASE XVI—White man, twenty-two years old Operation, hours after injury—One and one-half Location of wound—Anterior abdomen through umbilicus Operative findings—Two perforations small intestine, moderate hæmorrhage Operation—Enterorrhaphy, suture, drainage Time and autopsy cause of death—Thirty-two hours, hæmorrhage, rapid peritonitis

CASE XVII—Colored man, twenty-one years old Operation, hours after injury—Two Location of wound—Lower left abdomen, anterior Operative findings—Six perforations small intestine, laceration of mesentery, severe hæmorrhage Operation—Enterorrhaphy, suture, drainage Time and autopsy cause of death—Five days, general peritonitis retroperitoneal hæmorrhage

CASE XVIII—White man, twenty-four years old Operation, hours after injury—?

Wound of pancreas, two perforations of stomach, two of small intestine, severe hæmorrhage Operation—Gastrorrhaphy, enterorrhaphy, drainage Time and autopsy cause of death—Twelve hours after operation, pulmonary œdema hæmorrhage, shock Wound of liver and left kidney overlooked

CASE XXVIII—White man, twenty-two years old Operation, hours after injury—? Location of wound—Upper left abdomen from back Operative findings—No visceral injury, wound of aorta Operation—Exploratory laparotomy, control of hæmorrhage with clamps, drainage Time and autopsy cause of death—Eight hours, hæmorrhage, shock

CASE XXIX—Colored man, forty-two years old Operation, hour after injury—One Location of wound—Lower right abdomen, lateral, multiple Operative findings—Two perforations stomach, two of jejunum, severe hæmorrhage Operation—Gastrorrhaphy, enterorrhaphy, suture, drainage Time and autopsy cause of death—Three days, hæmorrhage, pneumonia, no autopsy

CASE XXX—Colored man, thirty-eight years old Operation, hour after injury—One Location of wound—Upper left abdomen, lateral to right Operative findings—Wound of liver, gall-bladder, five perforations small intestine, two of transverse colon, severe hæmorrhage Operation—Enterorrhaphy, packing drainage Complication—Peritonitis Time and autopsy cause of death—Five days, peritonitis, hæmorrhage gall-bladder, sutures leaking

CASE XXXI—White man, thirty-eight years old Operation, hours after injury—One Location of wound—Upper left abdomen, anterior Operative findings—Wound of left kidney, two perforations stomach, injury to mesentery, severe hæmorrhage Operation—Nephrectomy, gastrorrhaphy drainage, suture ligation, transfusion Time and autopsy cause of death—One day, hæmorrhage, shock Wound to pancreas overlooked Condition critical at operation

CASE XXXII—Colored man, thirty-seven years old Operation, hours after injury—One and one-quarter Location of wound—Upper right abdomen, anterior Operative findings—Four perforations ileum, three of cæcum, slight hæmorrhage Operation—Enterorrhaphy, suture, drainage Complication—General peritonitis Time and autopsy cause of death—Five days, hæmorrhage, general peritonitis

CASE XXXIII—Colored man, thirty-eight years old Operation, hours after injury—One and three-quarters Location of wound—Upper left abdomen Operative findings—Two perforations jejunum, one of ileum, three of descending colon at mesenteric border, slight hæmorrhage Operation—Enterorrhaphy suture, drainage Time and autopsy cause of death—Four hours, hæmorrhage, alcoholism, shock

CASE XXXIV—Colored man, thirty-three years old Operation, hours after injury—One and one-half Location of wound—Upper right abdomen, anterior, multiple Operative findings—Four perforations small intestine one of cæcum, two descending colon, several of mesentery two of omentum, severe hæmorrhage Operation—Enterorrhaphy, resection small intestine lateral anastomosis, cecostomy, suture, ligation drainage Time and autopsy cause of death—thirty-six hours, hæmorrhage, shock, peritonitis

CASE XXXV—White man, forty years old Operation, hours after injury—Twenty-seven Location of wound—Upper right abdomen, lateral from back Operative findings—Severe wound of liver, four perforations of mesentery, severe hæmorrhage Operation—Laparotomy packing, drainage Complications—Considerable wound bleeding on coughing Time and autopsy cause of death—twelve hours, hæmorrhage, shock, early peritonitis Wound of duodenum overlooked

CASE XXXVI—White woman twenty-five years old Operation, hours after injury—Four Location of wound—Lower abdomen, right chest Operative findings—Wound of liver, two perforations stomach, four of transverse colon, severe hæmorrhage Operation—Gastrorrhaphy, enterorrhaphy, suture, transfusion Complication—Cystitis

no drainage Time and autopsy cause of death—Fifteen hours after operation, hæmorrhage, shock Wound of liver overlooked

CASE XLVII—Colored man, twenty-one years old Operation, hours after injury—Two Location of wound—Upper left abdomen, multiple Operative findings—Two perforations stomach, two of small intestine, two descending colon, tearing wounds of colon at edge, severe hæmorrhage Operation—Gastrorrhaphy, enterorrhaphy, suture, drainage Time and autopsy cause of death—Twenty-four hours, hæmorrhage, shock, early peritonitis

CASE XLVIII—Colored woman, twenty-six years old Operation, hours after injury—Five Location of wound—Upper left abdomen, lateral Operative findings—Eight perforations ileum, one of mesentery, two of colon Operation—Enterorrhaphy, suture Complication—Local peritonitis, infected wound Time and autopsy cause of death—Nine days, died suddenly, peritonitis, embolus?, leakage from colon repair

CASE XLIX—Colored man, forty-eight years old Operation, hours after injury—Three and one-half Location of wound—Lower right abdomen Operative findings—Penetrating wound of abdomen, severe hæmorrhage, laceration external iliac vein and artery Operation—Laparotomy, ligation, drainage Time and autopsy cause of death—On table, hæmorrhage

CASE L—White man, fifty-two years old Operation, hours after injury—Two, Location of wound—Lower left abdomen, anterior Operative findings—Three perforations ileum, three of mesentery, severe hæmorrhage Operation—Enterorrhaphy, suture, ligation, drainage, transfusion Time and autopsy cause of death—Twelve hours, hæmorrhage, no autopsy

CASE LI—Colored man, twenty-nine years old Operation, hour after injury—One-half Location of wound—Lower right abdomen, lateral Operative findings—Four perforations small intestine, wound of bladder, severe hæmorrhage, fracture right ileum Operation—Laparotomy, marsupialization of bladder Time and autopsy cause of death—Three days, hæmorrhage, sepsis

CASE LII—Colored man, thirty-four years old Operation, hours after injury—Four Location of wound—Left abdomen, lateral, multiple Operative findings—Seven perforations jejunum Operation—Enterorrhaphy, drainage Complication—Infected wound, lobar pneumonia Time and autopsy cause of death—Five days, Pneumonia, peritonitis

CASE LIII—Colored man, thirty-seven years old Operation, hours after injury—Two and one-half Location of wound—Upper left abdomen, anterior, right chest, anterior Operative findings—Six perforations jejunum, one of ascending colon, superior mesentery artery severed, severe hæmorrhage Operation—Laparotomy Complication—Right hemothorax Time and autopsy cause of death—On table, hæmorrhage

CASE LIV—White man, fifty-five years old Operation, hours after injury—Fifty Location of wound—Upper left abdomen Operative findings—One perforation jejunum Operation—Enterorrhaphy Complication—General peritonitis Time and autopsy cause of death—On table, peritonitis, hæmorrhage

CASE LV—Colored woman, twenty-four years old Operation, hours after injury—Two and one-half Location of wound—Right flank Operative findings—Six perforations small intestine, three of descending colon, several lacerations mesentery, severe hæmorrhage Operation—Enterorrhaphy, suture, drainage Time and autopsy cause of death—Nine hours, hæmorrhage, shock, early peritonitis

*Gunshot-wound Injuries—No Operation—Death*

CASE I—White boy, eighteen years old Condition on admission—Moribund Time and autopsy cause of death—Ten minutes, hæmorrhage and shock, wound of pyloric end of stomach, vessels in front of spine

CASE II—White man, twenty-six years old Condition on admission—Moribund

CASE XX—White man, twenty-three years old Condition on admission—Moribund Time and autopsy cause of death—Two hours, hæmorrhage and shock, large liver wound, grazed side of upper lumbar spine, blood in abdomen

The liver was injured in 22 cases (no associated injuries in 11)  
 The stomach was injured in 9 cases (no associated injuries in 1)  
 The small intestine was injured in 18 cases (no associated injuries in 8)  
 The large intestine was injured in 8 cases (no associated injuries in 3)  
 The spleen was injured in 3 cases (no associated injuries in 2)  
 The pancreas was injured in 2 cases  
 The kidney was injured in 3 cases (no associated injuries in 1)  
 The bladder was injured in 3 cases (no associated injuries in 2)  
 The ureter was injured in 1 case

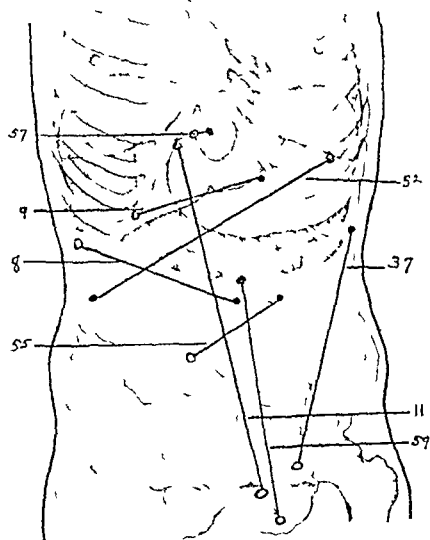


FIG 1—Gunshot wounds—operative recoveries ●—Wound of entrance ○—Wound of exit ○—Posterior wound Numbers refer to numbers in respective charts

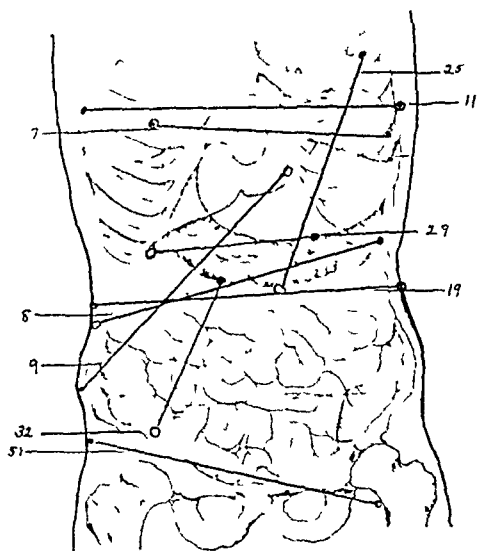


FIG 2—Gunshot wounds—operative deaths ●—Wound of entrance ○—Wound of exit ○—Posterior wound Numbers refer to numbers in respective charts

Resection of the small intestine was done in 3 cases (with end-to-end anastomosis in two and lateral anastomosis in one) A lateral anastomosis without resection was done in one case Splenectomy was done in one patient who developed tertian malaria during convalescence Nephrectomy was done in one case Two cases were transfused, and a re-infusion or replacement of 300 cubic centimetres of blood was done in a case of liver injury

Ten cases suffered wound infection, 3 of these occurring in 6 patients whose wounds were closed without drainage Three had general peritonitis, one had local peritonitis, and four had pneumonia

Two patients recovered without operation who were thought to have had visceral injury One was in a state of collapse on admission, with all the signs of massive internal hæmorrhage The pulse was imperceptible, blood

wall), spleen and left kidney in one (25)\*, duodenum in one (35)\*, pancreas in one (31)\*, and left kidney and liver in one (27)\*. In another case with severe hæmorrhage from a liver injury, wounds of the right kidney, diaphragm and right lung (23)\* were overlooked. Death occurred in twenty-six hours from hæmorrhage and shock. In another case with overlooked wounds of stomach, spleen and diaphragm (11)\* death occurred in forty hours from hæmorrhage and shock. A wound of the pancreas (14)\* was overlooked in a case of liver, diaphragm and cord injury with severe hæmorrhage. Death occurred in sixteen days from peritonitis and urinary-tract infection. Another case (7) in whom a wound of the liver and posterior wall of the stomach was overlooked lived for twenty-four days. Sub-phrenic abscess and sepsis was the cause of death. In three cases (4, 21, 48)\* that died of peritonitis or infection, leakage had occurred subsequent to the repair of perforating wounds of the intestine (duodenum, 1, colon, 2), and probably in each instance was a big factor, if not the direct cause, of death.

In regard to the overlooked injuries, we believe that their occurrence is more common than is generally supposed. The most convincing proof of the correctness of this statement will come from an autopsy "check-up" with operative findings. Those who have had experience in dealing with injuries such as are represented in this group of operative deaths will appreciate the difficulties often encountered at operation, and the ease with which such an error may be committed. The 9 cases in which lesions were overlooked were in very critical condition at the time of operation. Several of them had failed to show any reaction from shock after the use of the usual anti-shock measures, and their condition had rapidly changed from bad to worse because of continued bleeding, the operation having been done primarily for the control of hæmorrhage. Under such circumstances the amount of the anæsthetic and the time required for the operation assume more than the usual importance in the result. It is in such cases that blood transfusion will be of the greatest value. By this means the patient's condition may be so improved that the surgeon can go ahead with a thoroughly satisfactory exploration, and a careful repair of all visceral injuries. The average time between injury and operation for the whole series was a little over three hours, which we believe is early enough. More errors are made in operating too soon than too late. It is important to give the patient a chance to react from shock. Hæmorrhage must be differentiated from shock, and a distinction must be made in the patients whose failure to react is due to continued bleeding. If the pulse is rapid (120 or above), and its rate is not reduced by resuscitating shock measures, hæmorrhage of a serious character may be suspected.

*In conclusion we suggest, first*, the more general and routine use of blood transfusion, and in selected cases of severe hæmorrhage without hollow visceral injury, the re-infusion or replacement of blood can be done to great advantage. *Second*, the adoption of measures calculated to further reduce

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\* Refers to case numbers in tabulation



# THE EVALUATION OF RESULTS IN 324 GASTRIC AND DUODENAL ULCERS<sup>1</sup>

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FROM THE FOURTH SURGICAL DIVISION OF BELLEVUE HOSPITAL

IN VIEW of the fact that most internists and surgeons are not in accord as to the permanency of cure after either medical or surgical treatment of ulcers, it was decided by Dr Carl G Burdick, Director of the Fourth Surgical Division, and Dr Alexander Lambert, Director of the Fourth Medical Division, Bellevue Hospital, to organize a combined clinic for the study of this disease. This clinic was started in January, 1928 and the cases admitted for the first three years have been reviewed. During this period we have observed 324 ulcers and the cases have been divided into the month and year of admission to determine whether there has been a seasonal relationship to ulcer symptomatology. It was felt that by taking the admission to the clinic one could determine more accurately the month in which the patient had periodicity of pain, rather than by relying on the history, as all of these patients live in Greater New York and would enter the clinic when their pain was most intense. In reviewing the histories with symptoms extending over eight to ten years, the patient usually cannot recall the month, or even the exact year, of onset. In our review, there was no seasonal relationship except a slight decrease in the months of August and September. (See Table I.) The reason for the large number of admissions for January and February of 1928 was due to the fact that all ulcer cases treated on the Fourth Medical and Surgical Divisions for the past ten years were written to and asked to return for observation.

It is of interest to determine whether the incidence of ulcer is on the increase or decrease, and an analysis of the total number of ulcers and the total admissions to Bellevue Hospital, from 1910 to 1930 inclusive, reveals an increase in the total number of ulcer cases and when worked out on a percentage basis also reveals an increase which is illustrated in Table II. These statistics were taken from the annual report of the hospital. One question that naturally arises is whether the diagnosis is not more accurately made now than in the beginning of the series. There seems to be little doubt that the roentgen diagnosis is more accurate at present, but Hirsch introduced the double meal method of gastro-intestinal examination at Bellevue Hospital in 1910, but, of course, there were fewer cases to examine then than now. Also, refinements have been made in the technic of examination. The assumption that as many ulcers existed in 1910 as in 1930, but were unrecognized at that time, would lead one to believe that the complications of perforation and hæmorrhage should have been much more common twenty years

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<sup>1</sup> Read by title before the American Gastro-Enterological Association, May 5, 1931

This report will not take up the end-results of medical or surgical management as it is felt that no accurate conclusions can be drawn from either

TABLE III  
*Showing Year of Perforation*

Year	Died	Improved	Total
1911	0	1	1
1912	2	0	2
1913	1	2	3
1914	0	4	4
1915	2	1	3
1916	0	2	2
1917	3	3	6
1918	1	4	5
1919	1	3	4
1920	0	3	3
1921	1	2	3
1922	1	4	5
1923	3	6	9
1924	1	7	8
1925	0	8	8
1926	3	5	8
1927	0	9	9
1928	0	9	9
1929	1	12	13
1930	2	9	11
Total	22	94	116

treatment unless the patient has been observed for at least ten years, and frequently examined during this time. The patients seen in the clinic during

TABLE IV  
*Year in Which Hemorrhage Occurred*

1911	4	1921	1
1912	1	1922	0
1913	2	1923	1
1914	1	1924	3
1915	1	1925	2
1916	1	1926	2
1917	0	1927	3
1918	1	1928	10
1919	0	1929	13
1920	0	1930	11
Total			57

past three years have been grouped as to location of lesion which is illustrated in Table V. During this period, 324 patients were seen and they have made a total of 3,452 visits. There were 214 unoperated cases in this group and

history of this patient, it would seem justifiable to assume that when a patient is under treatment for an ulcer of his stomach or duodenum, and the original lesion has responded satisfactorily, and the patient develops a second lesion in the stomach, that we are dealing with a primary carcinoma and not an ulcer, as it has been our experience that gastric ulcers heal much more readily under medical care than duodenal ulcers and therefore it is not logical to assume an ulcer would develop in some other site after the original one has healed and the patient still under treatment

There have been 110 cases operated upon that are now under observation. Of this number fifty-seven were operated upon for chronic ulcers and most of these previously to 1928, as we have referred only twenty patients for operation during the past three years. Several of these patients are more than ten years post-operative, but we are not attempting to call them cured. In studying the unsatisfactory results we find that most of the cases operated upon early in the disease will not do well regardless of the type of operation, but the cases that have had prolonged medical care, and develop an associated pancreatitis, usually do beautifully following a simple gastroenterostomy. Of the chronic ulcers that we are following, all were not operated upon at Bellevue Hospital but came there for relief of symptoms after having been operated upon in other institutions. There have been forty-seven gastroenterostomies and three partial gastrectomies, six Horsley's and one Finney pyloroplasty. We have had seven marginal ulcers under our observation. One patient, a man twenty-five years of age, was operated upon three months after the onset of abdominal pain and six months after his operation he had a marginal ulcer and within twelve months from the onset of the original pain he had been operated upon a second time when a partial gastrectomy was done for the marginal ulcer and the patient died as a result of same. Another man thirty-nine years of age, originally had a gastroenterostomy followed by a marginal ulcer. A second operation disconnected the gastroenterostomy. His pain returned and one year later he had a plastic operation for the duodenal ulcer but the pain persisted and two years later he had a second gastroenterostomy and it is now nearly two years since this operation and the patient has been symptom-free. This leaves five cases that had marginal ulcers which are being treated medically and their symptoms had been present from six to eighteen months before starting treatment and four out of the five patients are greatly improved and practically symptom-free under medical treatment, while the symptoms of one remain unchanged. There are seven patients who have been referred for operation who have had an associated chronic pancreatitis. All of these patients are symptom-free with a simple gastroenterostomy, their follow-up varying from six months to three years. Of the forty-six acute perforations that are being followed in the clinic, most of them are doing quite satisfactorily following a simple closure but four have undergone a second operation for pyloric stenosis one having to submit to a second operation within ten months, while the longest went five and a half years following the perforation, but it is felt that these patients should

# VOLVULUS OF A SIGMOID MEGACOLON

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Volvulus of the sigmoid loop of large intestine is apparently not an uncommon condition. It is described in text-books of diseases of the large bowel and is a well-recognized clinical entity. Volvulus of a giant sigmoid or megacolon, however, appears to be a much rarer condition. A recent experience with the latter type of volvulus and the collection of some sixty-three similar cases in the literature seem to justify the following report.



FIG 1—Volvulus of the sigmoid megacolon just before resection and two days after the original exploration

CASE REPORT—The patient was an Irish boy of eighteen who was admitted to the First Surgical Division of Bellevue Hospital with a chief complaint of pain in the abdomen of four days' duration. He had not moved his bowels in eight days. The present illness started with a slight pain about the umbilicus which became increasingly severe during the next four days. There was gradually increasing distension of the abdomen. There were slight nausea and vomiting the first day of the illness which returned the day of admission to the hospital. The patient had been unable to move his bowels in the preceding eight days. The administration of large doses of Epsom salts accompanied by numerous enemas failed to relieve this condition.

siderably smaller than the sigmoid. The remainder of the large intestine was distended but did not resemble the pelvic colon in any way. The wall of the involved loop was oedematous, purplish in color but not gangrenous and assumed its normal appearance as soon as the volvulus was relieved. The sigmoid mesocolon was extremely long, very much thickened and oedematous.

The giant sigmoid was then brought out on the abdominal wall and the first stage of a Mickulicz resection was done. The proximal and distal loops were united with interrupted sutures for a distance of three inches below the abdominal wall. By doing this we were able to exteriorize all of the pathologic bowel except that portion of the iliac colon which had no mesentery. The two united limbs were then sutured to the parietal peritoneum at the margins of the wound. The megacolon was then lifted in a direction perpendicular to the patient and an attempt was made to squeeze as much of the blood back into the general circulation as possible. A large tape was then passed



FIG. 3—A comparison between a barium enema three and one half months post-operative (left) and that of a normal individual (right)

about the base of the megacolon one inch anterior to the abdominal wall and tied as tight as possible, thus strangulating the loop. A 24 F catheter was then inserted into the proximal loop to allow for the escape of gas and fecal contents.

The immediate post-operative reaction was excellent. Large amounts of gas and fecal material drained through the catheter.

Two days later the megacolon was resected by means of the actual cautery, level with the abdominal wall (Fig. 1). At this time the very large vessels of the mesentery were tied.

Seven days post-operative a Mickulicz clamp was inserted in the shot-gun barrel openings. Twenty-four days post-operative there was a large opening between the proximal and distal loops. At this time several large masses of impacted feces were removed manually from the rectum. On the forty-second post-operative day the colostomy was closed. At the present time, seven months after operation, the patient is perfectly well and having one normal bowel movement a day. A barium enema two months post-operative shows some enlargement of the bowel above the site of anastomosis and some

- Pauchet in 1904 male, 35 years old Operative procedure, resection, end-to-end, result, death
- Garre in 1905 male, 28 years old, 180 degrees of volvulus Operative procedure, detorsion and fixation, result, recovery
- Bloodgood, J C, in 1906 male, 65 years old Operative procedure, resection, side-to-side, result, recovery
- Tuffier in 1907 male, 60 years old Operative procedure, colostomy, result, death
- Feldman, M, in 1908 male Operative procedure, colostomy, result, death
- Lecene, P, in 1908 male, 60 years old, 90 degrees of volvulus Operative procedure, detorsion and fixation, result, recovery
- Schmieden in 1908 male, 20 years old Operative procedure, colocolostomy, result, recovery
- Jeannel in 1908 male, 40 years old, 360 degrees of volvulus Operative procedure, colostomy, result, recovery
- Bessel-Hagen in 1908 male, 6 years old Operative procedure, Mickulicz, result, recovery

Konjetzny, G, in 1910 male, 51 years old, 450 degrees of volvulus Operative procedure, Mickulicz, result, recovery

Konjetzny, G, in 1910 male, 24 years old, 180 degrees of volvulus Operative procedure, Mickulicz, result, recovery

Konjetzny, G, in 1911 male, 3 years

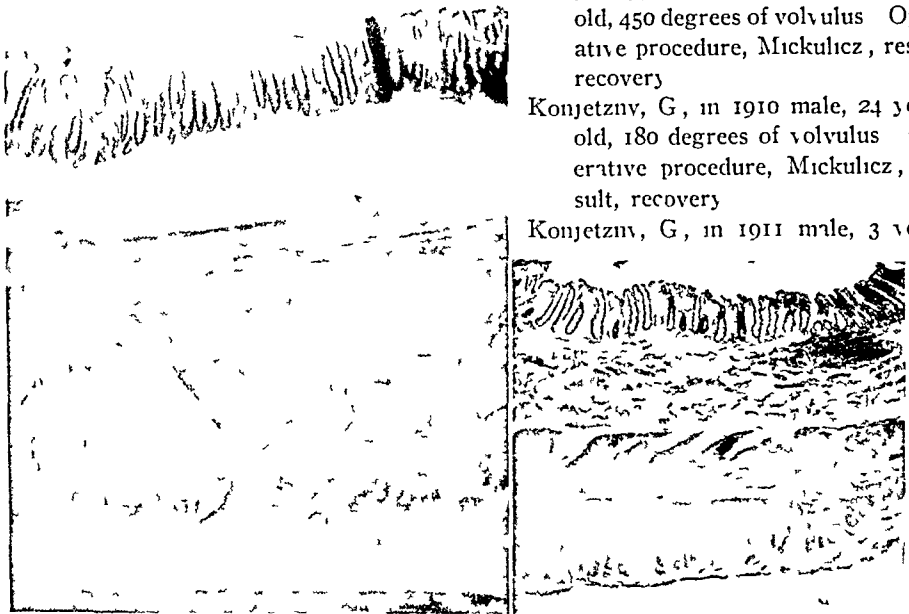


FIG 5—Comparison between the walls of the megacolon (left) and of normal sigmoid (right)  
(x 14)

- old, 180 degrees of volvulus Operative procedure, resection, end-to-end, result, recovery
- Clermont in 1911 male, 61 years old, 180 degrees of volvulus Operative procedure, colocolostomy, result, recovery
- Kraske in 1911 male, 27 years old, 360 degrees of volvulus Operative procedure, Mickulicz, result, recovery
- Critchlow, J F, in 1912 male, 42 years old Operative procedure, resection, end-to-end, result, death
- Gregoire, R, in 1912 female, 50 years old, 360 degrees of volvulus Operative procedure, resection, end-to-side, result, recovery
- Wideroe, S, in 1912 male, 98 years old, 180 degrees of volvulus Operative procedure, resection, side-to-side, result, recovery
- Lecene, P, in 1913 female, 42 years old Operative procedure, resection, end-to-end, result, death
- Delbet in 1913 female, 7 years old Operative procedure, detorsion, result, death
- Savariaud in 1913 male, 18 years old Operative procedure, detorsion, result, recovery

# CARNES WEEKS

Bonriot in 1924 male, 48 years old, 270 degrees of volvulus Operative procedure  
Mickulicz, result, recovery  
Hertz, J, in 1924 male, 60 years old, 900 degrees Operative procedure, Mickulicz,  
result, recovery  
Launay in 1925 male, 68 years old Operative procedure, resection, end-to-end, result,  
recovery  
Rochet in 1926 male, 48 years old, 540 degrees of volvulus Operative procedure, resec-  
tion, result, death  
Aumont in 1928 female, 30 years old, 90 degrees of volvulus Operative procedure,  
Mickulicz, result, recovery  
Brocq, P, in 1929 female, 34 years old, 720 degrees of volvulus Operative procedure,  
Mickulicz, result, recovery  
Weeks, C, in 1930 male, 21 years old, 900 degrees of volvulus Operative procedure,  
Mickulicz, result, recovery  
Roux de Brignolles, female, 50 years old Operative procedure, detorsion and fixation,  
result, recovery  
Michon, female, 79 years old Operative procedure, sigmoidostomy, result, recovery  
Heller, A, in 1904 male, 45 years old Operative procedure, autopsy  
Vene, M, in 1908 male, 72 years old, 90 degrees of volvulus Operative procedure, autopsy  
Konjetzny, G, in 1908 male, 4 months old, 180 degrees of volvulus Operative procedure,  
autopsy  
Kleinschmidt, H, in 1910 male, 5 months old, 90 degrees of volvulus Operative pro-  
cedure, result, autopsy  
Konjetzny, G, in 1911 female, 9 months old, 180 degrees of volvulus Operative proce-  
dure, autopsy  
Wiedhopf, O, in 1913 male, 70 years old, 180 degrees of volvulus Operative procedure,  
autopsy  
Schaaning, G, in 1919 female, 61 years old, 360 degrees of volvulus Operative pro-  
cedure, autopsy  
Belle, D A E, in 1920 male, 8 years old Operative procedure, autopsy

Table I gives a list and brief resume of sixty-three cases of volvulus of a sigmoid megacolon collected from the literature, including the author's case, which came to operation. It also includes eight cases in which the volvulus was discovered at autopsy and in which operation was not done. As complete an analysis as was possible has been made from the material submitted by the various authors on the operated cases.

TABLE II

Sex			Age
Males	42	- 10	4
Females	21	11- 20	4
Not reported	1	21- 30	9
	—	31- 40	7
	64	41- 50	16
		51- 60	12
		61- 70	5
		71- 80	3
		81- 90	0
		91-100	1 (age 98)
		Not reported	3
			64

\* Immediate resection of the volvulus

TABLE V—*Complications*—Gangrene of involved loop, 8 cases, 5 deaths, peritonitis, 5 cases 2 deaths, perforation of bowel, 1 case, 1 death, vessels of mesosigmoid (thrombosed), 3 cases, 2 deaths

TABLE VI—Number of cases described as megacolon, 64, hypertrophy of all coats mentioned in 18 cases, length of megacolon mentioned in 24 cases, average, 76 centimetres, measurement of normal sigmoid, 40 centimetres, circumference mentioned in 11 cases, average, 35 centimetres, measurement of normal sigmoid, 12 centimetres, diameter mentioned in 15 cases, average, 12 centimetres, measurement of normal sigmoid, 4 centimetres, thickness of wall mentioned in 4 cases, average, 8.7 millimetres, measurement of normal sigmoid, 5 millimetres

In all of the sixty-four cases the chief finding appeared to be the large size of the sigmoid loop. Unfortunately, exact measurements were not given in twenty-eight cases. In these the authors emphasized the large size of the megacolon by various comparisons, with the large intestine of the horse, the thigh or hip of an adult, *etc*

TABLE VII—Dilatation of other portions of the colon, 7, entire large bowel (Hirschsprung's disease), 2, transverse and descending, 2, distal half of transverse and descending, 1, descending, 1, mentioned but not designated, 1. Total, 7

It is interesting to note that only a little over 1 per cent of these cases shows involvement of any portion of the remainder of the large bowel and in but two was there evidence of dilatation of the entire large intestine

TABLE VIII—*Operative procedure, resection*, Mickulicz, three stage, 18 cases, 2 deaths, resection, end-to-end anastomosis, 15 cases, 4 deaths, resection, side-to-side anastomosis, 6 cases, Mickulicz with immediate resection, 3 cases, 2 deaths, resection, type not mentioned, 2 cases, 2 deaths, detorsion, 5 cases, 3 deaths, detorsion and fixation, 5 cases, detorsion and colocolostomy, 2 cases, detorsion and ileo-sigmoidostomy, 1 case, detorsion and colostomy, 4 cases, 2 deaths. 61 cases, 15 deaths

Results not known in two cases. Mortality—24.5 per cent. From the above figures and with the experience of the author's case the Mickulicz type of resection in three stages would seem to be the safest procedure

Whether this condition is congenital or acquired seems difficult to determine. In no one of the sixty-four cases was there any mention made of an obstruction which might have been the cause of the megacolon. There have been many theories put forward as to the possible etiology of this disease and one is that a chronic volvulus due to the long mesosigmoid may eventually cause hypertrophy. But as Mummery says, "Even when such a condition as a chronic volvulus exists this may be a secondary consequence of the dilatation, and not its cause." In his 100 collected cases of this disease he found evidence of obstruction in only twenty-three. In this connection he says, "The fact remains that in the great majority of cases no obstruction of any kind is found and also that in several the dilatation extended right down to the anus or middle of the rectum." That acquired megacolon is a possibility is shown in a recent article by Shelley in which it was possible to follow the development of dilatation of the large bowel subsequent to a stricture of the rectum



# CARNES WEEKS

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contractility of the bladder's muscular coat. If this is true, the fact that the bladder has a muscular coat, moots the question. However, that cannot be discussed here. But whatever the truth of it may be, compression, up to some unknown degree, seems to be the determining factor in forcing the mucous membrane to herniate into an extravesical sac. It must not, however, be forgotten that unless ectopia of the muscular fasciculi be present, neither the obstruction, distention nor compression can give rise to the deformity.

To elucidate the primary or congenital cause of these diverticula, it will

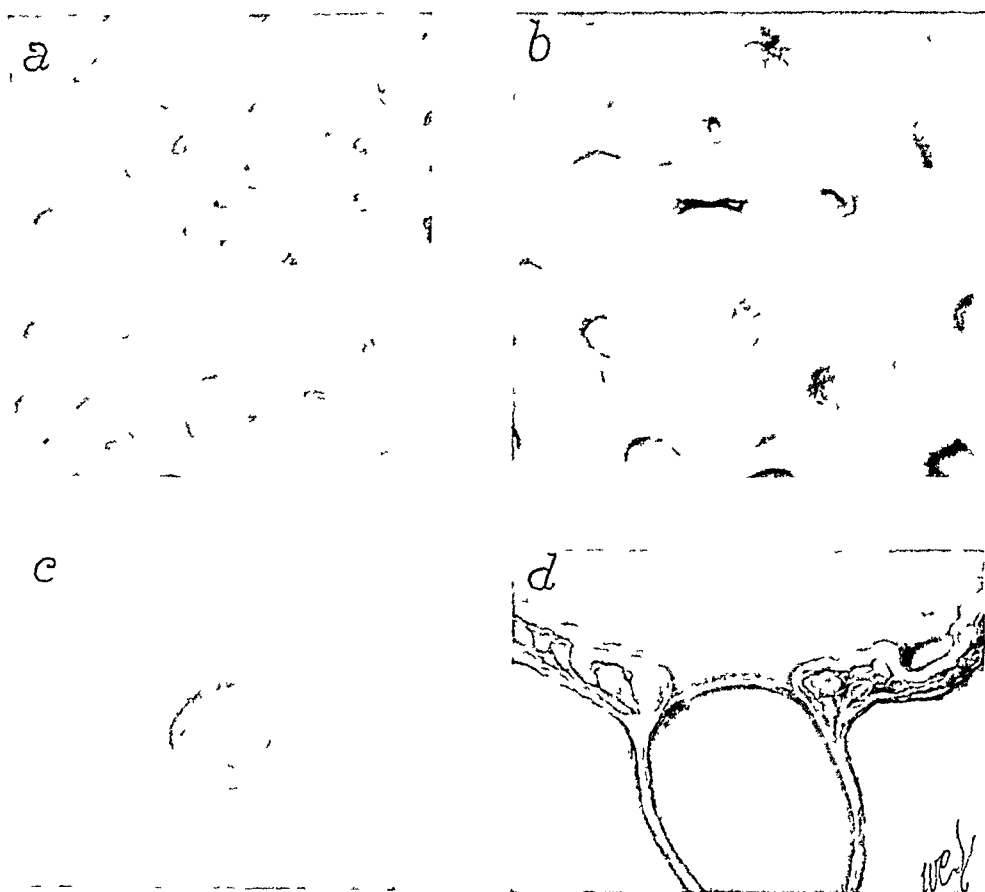


FIG 1 —(a) Small sacculations the fasciculi are not displaced to a degree capable of pouting the bladder's mucosa into a diverticulum. (b) Large sacculations. Here are the openings that lead to a sac only. Diverticulitis is not to be expected where so many large sacculations are present. It may occur but the fasciculi are usually discouragingly arranged. (c) Typical opening into diverticulum. Note the fibrous ring. (d) Section of diverticulum.

be necessary to briefly review the embryologic development of the genito-urinary tract. In doing this, we will find something to puzzle over when through speculative curiosity, we would like to find out the time that the kidneys begin the first secretion of urine.

Of course, this question is irrelative. Perhaps it should have been omitted, yet it is an emphasis on that which is of paramount interest, for it becomes apparent that unless the allantois had opened into the ventral cloaca in time to save itself from becoming distended by the urine from the newly functioning

ring This ring must be removed else union will be thwarted The incision should be an elliptical one, its long axes directed to the securing of the best working facilities It includes the entire fibrous ring with the mouth and end of the sac With this accomplished, the freed portion is grasped with light forceps and gentle traction is continued into the bladder while a gauze-capped finger gently pushes back whatever tissue may be adherent If the opening thus made in the wall of the bladder is large enough to admit a finger without the likelihood of tearing, the fibrous ring may be severed by a snip

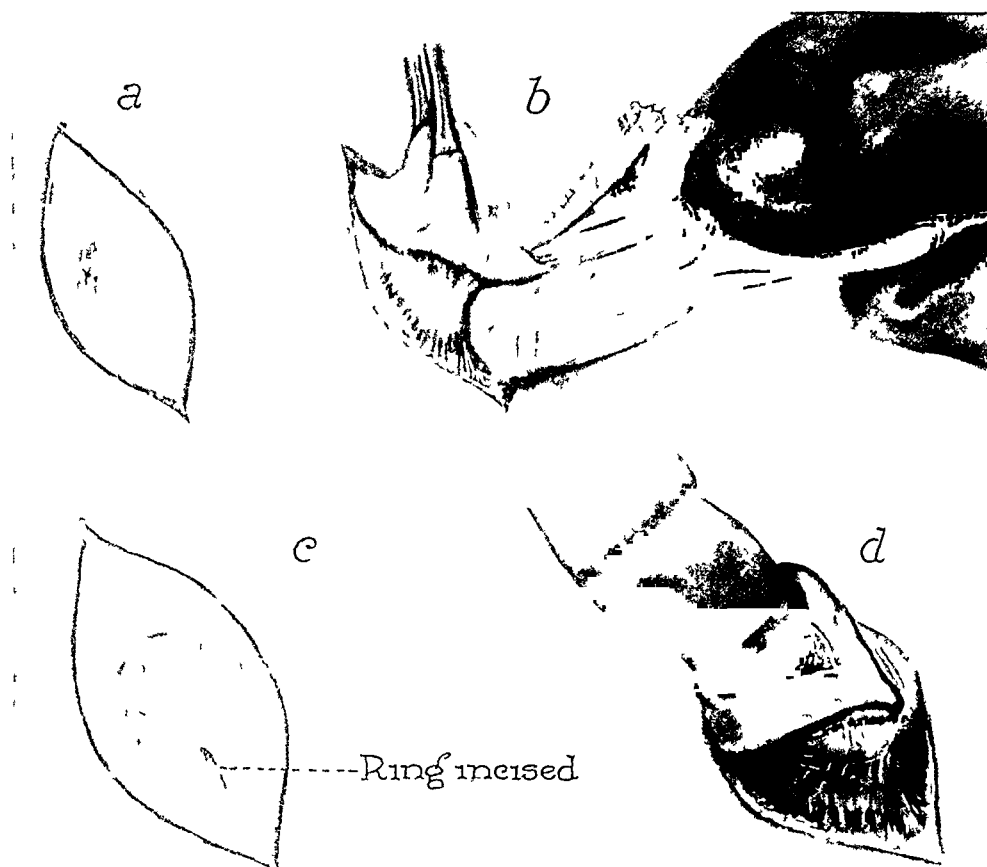


FIG 2—(a) Elliptical incision preliminary to dissection of the diverticulum (b) Ellipse with opening into sac being drawn into bladder while a gauze-capped finger pushes back all adhering tissue (c) Ring incised to admit finger (d) Once the sac is made free a finger within facilitates the dissecting

of the scissors and the further dissecting of the sac facilitated by inserting a finger within it Throughout the time it may require to complete the removal of the sac and the subsequent closure of the opening, sopping with sponges will take care of the urine that is coming in from the ureters

The ease with which the water-shed closure of the opening may be effected will, of course, depend very much upon what portion of the bladder wall is involved If high, and easily reached from the suprapubic incision, little difficulty need be expected When, however, it is low, and the diverticulum

# EXTIRPATION OF PREGNANT UTERUS AT FULL TERM \*

By WILLIAM WERTENBAKER, M D

OF WILMINGTON, DEL

FROM THE DEPARTMENT OF GYNECOLOGY AND OBSTETRICS OF THE WILMINGTON GENERAL HOSPITAL

ABOUT March 1, 1928, Dr M A Tarumianz, of the Delaware State Hospital for the Insane, at Farnhurst, referred to me a Negress, aged thirty-three years, the subject of general paresis. She was the mother of six children, only two living and both mentally deficient, she was at that time within ten days of term with another pregnancy, her Wassermann was four plus, there was a profuse cervical discharge which showed numerous gonococci. To further complicate the situation, the foetal breech was lying in the right iliac fossa. The indications called for (1) Avoidance of the spread of gonorrhœal infection, (2) sterilization of the mother, and (3) delivery of the foetus. To accomplish these triple ends I decided to remove the entire uterus before rupture of the membranes.

On March 15, 1928, the abdomen was incised in the lower mid-line, the broad ligaments clamped on each side and incised down to the level of the cervix. Two clamps sufficiently long to reach across the entire cervical bridge, were thrown into place and the uterus delivered from the abdomen. The cervix was severed with a single cut between the two clamps, the uterus, with its contents, was passed to an assistant, Doctor Pawlikowski, who extracted a living foetus weighing seven pounds, two ounces. The time consumed from start of abdominal incision to delivery of child was less than four minutes.

The cervical stump was cauterized and turned in with a running suture, the stumps of the round and infundibulo-pelvic ligaments ligated, brought down and sutured to it. A fold of the utero-vesical peritoneum was then brought over all to complete the peritoneal toilet. One cigarette drain was placed in the cul-de-sac and the abdomen closed in three layers.

This woman made an uneventful surgical recovery.

Since that time I have met with five other cases in which it was felt wise to adopt a similar line of procedure. Two were cases in whom one or more previous Cæsarean sections had previously been made in whom numerous pelvic and abdominal adhesions were doubtless present, one a case of marked hyperthyroidism with uterine fibroids, another a woman exsanguinated by hæmorrhage due to placenta previa, in which case a minimum of blood loss at delivery was felt essential to give her any chance, which she might possibly have, of recovery.

These cases were operated upon respectively on July 19, 1930, December 20, 1930, January 12, 1931, February 18, 1931, April 3, 1931. All six babies were delivered alive, five mothers made uneventful recoveries and left the hospital in good condition. One mother (Case II) developed a vesico-abdominal fistula on the ninth day, which was closed at a subsequent operation.

In Case IV violent uterine contractions began as soon as an attempt to deliver the uterus from the abdomen was made, and the membranes ruptured just as this was accomplished, so, after the "waters" had drained away, a

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\* Read before the Kent County Medical Society, Dover, Delaware, April 1, 1931

CASE III—Millington, Md Age, twenty-seven years, Para V Referred by Doctor Brice

Pregnancy at thirtieth week Free uterine hæmorrhage Full placenta previa

Operation—December 20, 1930 Anæsthesia—Gas (only)

Infant—Male, living but premature, weight not recorded N B—This infant died in sixty-two hours Autopsy—Patent foramen ovale Prematurity

Surgical Convalescence—Uncomplicated Mother discharged in good condition on January 4, 1931—fifteenth day

CASE IV—Wilmington, Del Age, thirty-five years, Para I Referred by Dr B J McEntee

Hyperthyroidism Uterine fibroids Term pregnancy

Operation—January 8, 1931 Anæsthesia—Gas (only)

Infant—Female, condition good, weight 6 pounds, 12½ ounces

Surgical Convalescence—Uncomplicated Discharged in good condition on sixteenth day

CASE V—New Castle, Del Age, twenty-nine years, Para II Referred by Dr Lewis Booker

Term pregnancy Contracted pelvis Previous Cesarean section Pelvic adhesions

Operation—February 18, 1931 Anæsthesia—Spinal

Infant—Female, condition good, weight 8 pounds, 8 ounces

Surgical Convalescence—Uncomplicated Discharged on seventeenth day in good condition

CASE VI—Wilmington, Del Age, twenty-nine years, Para III Referred by Dr Fred Armstrong

Term pregnancy Contracted pelvis Two previous Cesareans

Operation—April 3, 1931 Anæsthesia—Spinal

Infant—Female, condition good, weight 6 pounds, 1½ ounces

Surgical Convalescence—Uncomplicated Discharged on fourteenth day in good condition

*Comments*—At the time the first operation was performed no thought of attempting a new procedure was entertained It was approached entirely with the idea of working out what was best for the particular case However, as other cases were brought to us to which the same principles could be advantageously applied, variations were tried and discarded or adopted, oftener the former

In Case I Doctor Tarumianz desired the removal of the ovaries for psychiatric reasons, so the infundibulo-pelvic, round and broad ligaments were clamped and cut distal to the tubes and ovaries In the same case only so much of the utero-vesical peritoneum was reflected as would serve as a flap for the cervical stump

In subsequent cases it was found that the former was easier than where it was desired to conserve the ovaries and tubes, but, on the other hand, that the reflection of the utero-vesical peritoneum and bladder not only gave a neater result but otherwise expedited the operation

In Case IV delivery of the uterus from the abdomen was done before reflection of the utero-vesical peritoneum and severing of the broad ligaments This was found a distinct handicap rather than an advantage

The use of gauze sponges, or pads, was discarded until after delivery of

## INTERPARIETAL HERNIAS

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OF CLEVELAND, OHIO

FROM THE CLEVELAND CLINIC

THE term "interparietal hernia" is used collectively to designate a group of rather unusual hernias which are located in the inguinal region between the various layers of the abdominal parietes. Anatomically, these hernias may be classified as follows: (1) Properitoneal hernia, that type in which the hernial sac lies between the peritoneum and the transversalis fascia, (2) interstitial hernia, in which the sac lies between the transversalis fascia and the transversalis, internal oblique, or external oblique muscles, and (3) superficial hernia, in which the sac is situated between the aponeurosis of the external oblique muscle and the integument.

Since interparietal hernia has been spoken of by all authorities as being of rare occurrence it is surprising to find that 587 cases have been reported in the literature. The inability to diagnose this condition pre-operatively and the consequent high mortality rate indicate how superficial is our knowledge of this type of hernia. Since the days of Thomas Bartholin (1661), many noted surgeons have been chagrined because they failed to recognize this type of hernia at the operating table, the mistake being revealed at recropscopy.

Because of these considerations, we feel justified in presenting a clinical study of interparietal hernias based on cases observed at the Cleveland Clinic and those reported in the literature.

### TWO CASES OF INTERSTITIAL HERNIA

CASE I.—The patient, a truck driver, aged fifty-eight, reported at the Cleveland Clinic April 27, 1929, complaining of pain occurring low in the left side.

Four years previously, a severe pain suddenly developed in the lower left abdominal quadrant radiating downward toward the bladder and penis. The paroxysm lasted about thirty minutes and then subsided, leaving him perfectly well. There had been no nocturia, frequency, burning on urination, urgency, nor hematuria, and the urine had never contained any gravel.

Three months later a similar attack occurred, and since then the attacks had progressively increased in frequency and severity. Most of the paroxysms were initiated by work, exercise, lifting, or straining, and were always associated with the act of defecation. When the patient lay down, the pain immediately disappeared, often recurring, however, as soon as he stood up. He had never observed any swelling in the groin, and emphatically denied being "ruptured." Both testicles had always been in the scrotum. The day before his admission to the clinic he had an attack of severe pain in the left groin and felt nauseated but did not vomit. The pain was intense while he was working, but subsided when he assumed a recumbent position. Some soreness was present in the region of the left groin.

The general physical examination showed a well-nourished adult male. The temperature was 97.6°, the pulse rate 64, and the blood-pressure 135/100. The pupillary

rigidity but no feeling of fluctuation. The gall-bladder could not be palpated on account of the tenderness in this region. In the right groin, just above the external inguinal ring, was a small swelling which increased in size on straining and to which a definite impulse was imparted by coughing. The external ring was small, and no enterocele could be palpated in the canal. Both femoral rings and the left external inguinal ring were normal.

The pre-operative impression was that an abscess of the gall-bladder was pointing in the old cholecystostomy scar, and that an interstitial hernia was present in the right inguinal region. The latter diagnosis was made because of our experience with the previous case.

A transverse incision was made over the right inguinal canal. A probe was readily introduced into the canal through the external ring, and no enterocele or obstruction was encountered. On palpation, a small tumor-like mass could be felt just near the outer side of the canal. An incision was made directly over the swelling, and as soon as the fibres of the external oblique muscle were separated, a small, partially collapsed hernial sac was seen lying between the two oblique muscles. When this sac was opened, a few tags of omentum were disclosed. The sac was carefully dissected free from the adjacent structures, to which it was fairly adherent. It lay in direct apposition to the lateral walls of the inguinal canal, pierced the internal oblique and transversalis muscles, as well as the transversalis fascia, and opened into the peritoneal cavity by its individual orifice, situated just lateral to and above the internal inguinal ring. The round ligament entered the inguinal canal through a normally located inguinal ring, and there was no communication between this canal and the interstitial hernia. The sac was ligated, the aperture through the abdominal wall was closed, and the patient made an uneventful recovery.

In both of the cases described above the condition was caused by a simple interstitial hernia, the sac in each instance being contiguous to but not communicating with the inguinal canal, each having its own separate orifice. Kronlein has discussed this type of hernia to which, because of its juxtaposition to the inguinal canal, he gave the name "para-inguinal interstitial hernia."

As there are three anatomical varieties of interparietal hernia—properitoneal, interstitial and superficial hernias, these will be discussed separately.

#### PROPERITONEAL HERNIA

The first authentic report on interparietal hernias was made by Bartholin in 1661, but his description was not sufficiently complete to permit classification. In 1779 Petit described a group of hernias which were situated within the interstices of the abdominal wall. In 1839 Parise saw a hernia in which the sac was situated between the peritoneum and the transversalis fascia, and in 1851 he described it under the name of "intra-iliac hernia." In 1864 Streubel collected reports of fourteen cases. The most important work however was done by Kronlein, a report of which was published in 1876. He collected and analyzed twenty-three cases which had been reported up to that time, he carefully described the anatomical positions and clarified the etiologic factors concerned in their production, giving to this type of hernia the name "hernia inguinoproperitonealis." In 1895 Breiter, a pupil of Kronlein, collected thirty-six additional cases, and in 1900 Gobell brought the literature up to date, presenting a series of sixty-nine cases. Since that time

case of an inguinal hernia and a coexisting properitoneal hernia. These hernias were separate and distinct, each opening into the abdominal cavity through an individual orifice. In 1902, Howlett reported a case of a bilocular properitoneal hernia in which both loculi were situated between the peritoneum and transversalis fascia, one sac extending upward and outward and the other downward and inward. At the first operation only one sac was recognized, but as the symptoms of nausea and vomiting persisted, a second operation was performed which revealed a loop of strangulated bowel in the second properitoneal sac. This is a good example of a properitoneal hernia occurring outside of the inguinal canal but lying adjacent to it.

It would seem, therefore, that properitoneal hernia, in both the monocular and the bilocular forms, may be classified as follows: (1) Inguinoproperitoneal hernia, which occurs as a diverticulum from a preexisting inguinal hernia. (2) Cruroproperitoneal hernia, which occurs as an outpouching of a femoral hernia. (3) Simple properitoneal hernia which is independent of the inguinal or femoral canals.

The anatomical positions which may be assumed by the properitoneal sac must be clearly understood if these hernias are to be treated surgically. Usually it occupies one of three positions: (1) It may pass upward and outward toward the anterosuperior iliac spine. This is the usual position. (2) It may pass directly backward, and occupy the iliac fossa. This form is often mistaken for a retroperitoneal hernia, and its relation to the inguinal canal is forgotten. (3) It may pass downward and inward to the side of or in front of the bladder. This type has been called the inguovesical or prevesical hernia.

*Etiology*—Precise knowledge concerning the formation of properitoneal hernia is wanting, as is attested by the number of theories which have been advanced, of which only a few of the most logical can be discussed.

After making a meticulous study of the inguinal canal, Eppinger decided that its anatomical structure was such that it predisposed to the formation of properitoneal hernia. He arbitrarily divided the canal into three portions: (1) The innermost section, which extends from the internal inguinal ring to the point where the infundibuliform fascia pierces the transversalis muscle. In this portion of the canal the transversalis fascia is firmly adherent to the transversalis muscle, but only a few fibrous tissues connect it with the peritoneum, this space being filled with loose, non-resisting fatty tissue. (2) The middle portion of the canal, which is 10 to 12 centimetres long, and is surrounded by the internal oblique and transversalis muscles. Here the muscular reinforcement precludes the formation of interparietal hernias. (3) The anterior segment of the canal, which corresponds to the space between the internal oblique muscle and the external inguinal ring. The two oblique muscles are loosely attached to each other by strands of connective tissue, and the interstices are filled with loose, yielding, adipose tissue. It is thus evident that the weakest points in the inguinal canal are



trionship between the sac and its content The reduced hernia always lies outside of the peritoneum

To us it seems that the difficulty encountered in separating a hernial sac from its surrounding structures during herniorrhaphy would preclude dislocation of the hernial sac en masse by simple taxis Streubel and Halstead believe that such cases of reduction en masse are merely the transference of the content of a scrotal or crural sac into a preformed properitoneal sac Moynihan reviewed the specimens of reduction en masse in Guy's Hospital Museum, and concluded that most of them were from cases of properitoneal hernia In studying the reports of cases of reduction en masse, we found that the description of the operative findings was so meager that the true anatomical position of the sacs could not be determined We agree with Halstead and Moynihan, however, that examples of true reduction en masse are rare, and that most of the cases which purport to be of this nature are really cases of properitoneal hernia

In contrast with the theory of the mechanical origin of properitoneal hernia are the arguments of those who believe that all hernias are congenital Rokitansky pointed out that in many cases small peritoneal pouches or diverticula could be seen in the immediate neighborhood of the internal inguinal ring, these he believes, constitute the anlage of properitoneal hernia Brunner, Englisch, and Wagner also noticed these small peritoneal pouches, and thought them responsible for interparietal hernias In 1884, Wagner confirmed his convictions by finding a case of inguinal hernia with a coexisting properitoneal hernia which lay adjacent to the inguinal canal but did not communicate with it Russell maintains that all hernias are congenital and that the process vaginalis can be caught up between the layers of the abdominal muscles and form any variety of interparietal hernia In a series of 200 post-mortem examinations, Raw and Murray found sixty-eight peritoneal diverticula, fifty-two of them being femoral, thirteen inguinal, and three umbilical Murray believes that when these congenital diverticula or pouches exist, the occurrence of hernia depends on the size of the opening and the strength of the muscles that protect the orifice

Coughlin's anatomical studies of adults and Moynihan's of fetuses revealed that in 22 per cent of necropsies they could clearly demonstrate deep peritoneal pouches or fossæ near the obliterated hypogastric artery which easily could have developed into properitoneal hernias

Kirchner reports a case of such a properitoneal hernia arising in Hesselbach's triangle as the result of a peritoneal diverticulum near the obliterated hypogastric artery How can the occurrence of multiple hernias in the same individual be explained unless the theory of their congenital origin is accepted? Bambridge operated on a woman in whom six separate and distinct hernias were present Congenital malformation of a hernial sac is evident in the bifid or pantaloons hernias of Halstead, in which the inguinal sac is divided into two compartments like a pair of trousers and opens into the abdominal cavity through a normal internal inguinal ring

the diagnosis is obvious. In those cases in which there is no accompanying inguinal or femoral hernia, it is usually impossible to make a pre-operative diagnosis.

It is only by operation or post-mortem examination that the true nature of the hernia is revealed. Many surgeons have performed a herniotomy for strangulated inguinal hernia, removed the sac, and closed the wound, but when, to their surprise, symptoms of obstruction persisted and a subsequent operation was performed, a strangulated properitoneal hernia was found.

Of the cases reported since 1900 that we have collected, thirty-four were strangulated or incarcerated, four were reducible, and in twelve no history was given. The failure to make an early diagnosis and the resultant delayed operative intervention has resulted in a high rate of mortality. Torrey in 1888 reported thirty-five cases of strangulated properitoneal hernia, with an operative mortality of 80 per cent. In our series of fifty herniorrhaphies, there were ten deaths, and in twenty cases the results were not known, making a mortality of 20 per cent. or more.

The treatment of properitoneal hernia will be considered jointly with the treatment of the other types of interparietal hernias.

#### INTERSTITIAL HERNIA

The two cases we have presented are typical of this group of interparietal hernia. (See Cases I and II.)

From an autopsy specimen, Hesselbach, in 1814, presented an excellent illustration of this variety of hernia, with the sac lying between the internal and external oblique muscles. In 1812, Cooper observed and, in 1827, published an account of the first successful herniotomy for a strangulated interstitial hernia, the sac being situated between the two oblique muscles. In 1893, Macready was able to gather 163 cases of this form of hernia from the records of the London Truss Society, but as these cases were not verified by autopsy or operative findings, their diagnosis is uncertain. Interstitial hernia in women was first described by Berger in 1891, and Auvray in 1900 reported fourteen such cases. In 1900 Gobell collected 115 cases of interstitial hernia which had been found at operation or post-mortem examination. We have been able to gather sixty-five cases from the literature and have made two personal observations, making our series a total of sixty-seven. These, added to the figures reported by Macready and Gobell, make a grand total of 345 known cases of interstitial hernia.

*Definition and Anatomical Considerations*—In interstitial hernia the sac burrows its way between the layers of the abdominal wall, and may be found in any of the following positions: (1) Between the transversalis muscle and fascia, (2) between the transversalis and internal oblique muscles, (3) between the fibres of the internal oblique muscle, or (4) between the internal and external oblique muscles, the latter being by far the most common position. Many writers contend that the only variety seen is the form in which the sac lies between the two oblique muscles. Moynihan even goes

stitial hernias are not bilocular, for cases have been described which demonstrate that both trilocular and monolocular forms exist

In Ehler's interstitial hernia there were three sacs, one extending between the internal and external oblique muscles, one between the skin and superficial fascia, and the third descended into the scrotum. All three loculi communicated with each other and opened into the abdominal cavity through the internal inguinal ring. In the monolocular variety (Fig 4), the interstitial sac is a direct continuation of the inguinal hernia and not a diverticulum with an inguinal hernia descending farther down the canal. If the ectopic testicle is at the external ring and prevents the further descent of the hernia, the only direction in which the sac can expand is between the layers of the abdominal muscles. As there is no locus going down into the scrotum, the hernia must of necessity be monolocular. At operation, the enterocele

between the muscles is found to be a direct continuation of the sac that comes down the inguinal canal, while the process vaginalis is completely closed and in the majority of cases does not even descend into the malformed, empty scrotum. Gobell was able to collect reports of twenty-four such cases of monolocular interstitial hernias and eighty-four of the bilocular variety. In our series there were ten monolocular, thirty-six bilocular, and twenty-one that could not be diagnosed because of insufficient data.

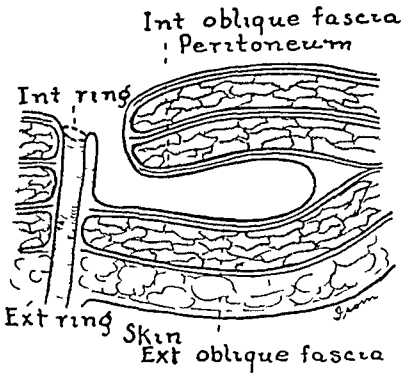


FIG 5—The authors case of interstitial hernia occurring outside the inguinal canal

In another variety of monolocular hernia the interstitial sac lies adjacent to but not communicating with the inguinal canal (Fig 5), and opens into the abdominal cavity through its own orifice, which lies near the internal inguinal ring. Kirchner describes such a case in which the sac does not involve the inguinal canal or the internal inguinal ring, but occurs as a separate and distinct entity. In the two cases which we have reported in this paper, the interstitial sac was completely outside the inguinal canal and may be classified as an extra-inguinal hernia of the interstitial variety. Perhaps some writers would consider this group as a form of ventral hernia, but its immediate proximity to the inguinal canal precludes this supposition.

*Etiology*—The same condition that contributes to the formation of properitoneal hernia contributes also to the production of the interstitial variety. The most satisfactory explanation of this form of rupture is based upon its connection with retained testicles. The testicle usually is situated at or just outside of the inguinal ring, and bars the further descent of the hernial sac, causing it to spread between the layers of the abdominal muscles. In Macready's 129 cases in males, abnormalities of the testicles were present in 73.4 per cent, and in 67.1 per cent there were congenital displacements of

No inguinal mass was present. We surmised that we were dealing with some abnormal form of hernia, the exact nature of which we did not know.

#### SUPERFICIAL HERNIA

Boyer, in 1822, was the first to describe a hernia which proceeded from the external inguinal ring and spread out between the aponeurosis of the external oblique muscle and the integument. He termed it intra-inguinal hernia. In 1886, Le Fort revived interest in this variety of hernia, but it remained for Kuester, in 1887, clearly to describe and define this rare condition, which he named inguinoperitoneal hernia. He presented histories of fourteen cases and discussed the probable etiologic factors concerned in their production. In 1903, Moschowitz collected sixteen cases and added one of his own. In 1905, Sellenings published reports of a series of twenty-seven cases which he had collected. In a review of the literature we have been able to accumulate records of ninety-six cases, some of which date back to 1893 and are not included in any of the aforementioned series. We realize that it is a hopeless task to collect all reported cases because of the variety of titles and subjects under which they have been published. Many reports of so-called superficial inguinal hernias had to be discarded because of insufficient data which made it impossible to determine accurately their anatomical position.

The addition to our series of that of Sellenings produces a total of 123 authentic cases of superficial hernia.

*Definition and Anatomical Considerations*—In inguinoperitoneal hernia the sac descends into the inguinal canal, then through the external inguinal ring, and spreads out between the aponeurosis of the external oblique muscle and the skin. The sac may occupy one of three positions: (1) It may pass laterally toward the anterosuperior iliac spine. This is the most common location. (2) It may extend upward and medialward toward the umbilicus, as in Broca's case. (3) It may pass downward over Poupart's ligament and come to lie directly over the femoral opening between the deep fascia of the thigh and the skin.

Cases belonging to the last group have often been described as inguinofemoral hernia. In fact, Twyman considers them a clinical entity and reports the cases of Hothouse, Key, and his own as being representative of this variety. It seems to us that these are true inguinoperitoneal hernias, and should be so classified. An inguinofemoral hernia, as the name implies, is one involving both inguinal and femoral canals. For example, an inguinal hernia passes down the inguinal canal as far as the lower part of the canal, then because of an anatomical defect it passes beneath Poupart's ligament and emerges through the femoral opening. In Twyman's case the hernial sac came through the external inguinal ring, passed downward over Poupart's ligament, and was found in the superficial tissue in Scarpa's area. The hernia was inguinal, and never came into contact with the femoral canal, hence it is merely a superficial inguinal hernia, and should be so classified.

However, as eight cases were found in males with normally placed testicles and seven were found in females, other etiologic factors must be sought. If the content of the hernial sac is suddenly increased and the scrotum cannot adequately take care of it, then the hernia must extend out between the external oblique aponeurosis and the integument. Moschowitz reports a case in which a testicle was retained in the inguinal canal. As the boy developed, the testicle gradually descended into the scrotum, but since the descent was accompanied by pain, he frequently forced the testicle and the accompanying congenital hernia back out of the scrotum. Following such a reduction, the testicle and hernia were forced out between the external oblique aponeurosis and the skin, as the external inguinal ring was too small to permit their return into the inguinal canal and abdomen. The hernia became strangulated, and at operation the sac was found to be as described. Repeated and indiscriminate taxis, therefore, may produce this form of hernia.

*Incidence*—The incidence of this group is very low. So far, only 123 cases have been described, 101 in males and seven in females, and in fifteen the sex was not mentioned. The average age is forty-five years.

*Symptoms*—The symptoms of superficial hernia usually are those of intestinal obstruction. Out of ninety-six cases, thirty were irreducible and presented symptoms of obstruction, twelve were reducible and in fifty-four no clinical history was given. In this type, a palpable tumor generally is encountered about Poupart's ligament, and when the scrotum is examined the testicle is missing. It must be remembered, however, that in a few cases the superficial sac may pass downward into the region of the femoral ring and be mistaken for a femoral hernia.

#### TREATMENT OF INTERPARIETAL HERNIA

As most interparietal hernias are either incarcerated or strangulated when the patient presents himself, immediate operative intervention is indicated. Delay merely increases the risk of mortality. If a patient presents symptoms of intestinal obstruction following an inguinal or femoral herniorrhaphy, an incarcerated properitoneal hernia should be suspected, and intervention should be instituted immediately. In all herniotomies, in order to be certain that an intermuscular sac has not been missed, the entire inguinal canal should be carefully explored. When operating on an interparietal hernia, the surgeon must remember that the strangulation may be at the internal ring, the neck of the interstitial diverticulum or sac, or the external ring. The abdomen never should be closed until the site of obstruction has been found. Generally, careful exploration will reveal the enterocele in a diverticulum.

In an operation for interparietal hernia, some surgeons prefer the inguinal approach, and then, if necessary, the incision can be extended until the abdomen is opened. Moynihan thinks that a combined abdomino-inguinal route is better. It seems to us that the latter is the more practical, as it precludes injury to the bowel, since the site of obstruction is more clearly revealed by this approach.

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## DUODENAL HERNIA

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WITHIN a period of three months, two cases of duodenal hernia were observed in the Surgical Service, Emory Division, Grady Hospital. They are of unusual interest in that one was of the left side and one of the right side according to the classification of Moynihan. Both cases were admitted with acute obstructive symptoms, the first diagnosed only by exploratory laparotomy with recovery, and the second diagnosed correctly but with a fatal termination.

From a search of available literature, the first description of duodenal hernia was by Klob, in 1861, who carefully described a case of the right-sided variety, though Trietz, in 1857, suggested the possibility of herniation at the duodeno-jejunal junction, describing anatomically the formation of the various folds and fossæ in this region.

A detailed analysis of reported cases was presented in 1906 by Moynihan, who, in his monograph, tabulated and explained the cases reviewed. Some one hundred case reports were embodied in this work and twenty of the patients recovered. The anatomic and embryologic interpretations of the two cases here reported are drawn from the descriptions detailed by him, though careful operative observations were made in both cases, supplemented by autopsy findings in the second case.

In order to properly report retroperitoneal hernia of this variety, it is necessary to review the embryology of the abdominal structures. The present theory is that, in common with most herniæ, a congenital potential sac must be present, which, in duodenal hernia, is formed by a fusion anomaly.

The intestinal canal at the fourth week of intra-uterine life is represented by a straight tube attached throughout its length to the mid-line of the body by a dorsal fold of peritoneum, the primitive mesentery. The stomach develops from a dorsal bulging of the tube, to which the primitive mesentery is attached, and a fold of peritoneum runs from the anterior abdominal wall, forming the lesser omentum.

By the sixth week, three segments supplied by special arteries are found. The first segment forms the stomach and duodenum and the celiac axis is contained within its mesentery. That portion of the mesentery lying behind the stomach forms, with the growth of the posterior wall of the stomach and its development to the right, the greater omentum. The head of the pancreas lies at the convex junction of the pylorus with the stomach. The distal end of the duodenum, where later the duodeno-jejunal flexure is found, lies in the median plane of the body, possesses no mesentery, and is therefore fixed to the posterior abdominal wall.

The second segment extends from the duodeno-jejunal flexure to the umbilicus and back to the posterior abdominal wall, the umbilical loop of Toldt, the two limbs of which are parallel and are united by a long, narrow mesentery containing the superior mesen-

(9) The para jejunal fossa also lies behind the superior mesenteric artery and is closely associated with the fossa of Waldyer

CASE I—(Figs 1, 3, and 4) A negro male, thirty years of age, was admitted to Emory Division of Grady Hospital at 9 30 A M, July 30, 1930, in extreme abdominal pain and shock. At 10 00 A M he had been taken with sudden, agonizing and paroxysmal pain over the entire abdomen, followed by vomiting a few minutes later and had retained nothing since. Notwithstanding the severity and constancy of the pain, he had not sought relief until twelve hours after the onset. For the past two or three hours he had been voiding an ounce or two of urine every ten or fifteen minutes and felt as if the bladder were filled. Except for a gnawing pain in the epigastrium three or four hours after meals occasionally, there have been no digestive disturbances.

The family history is unimportant and the past history is irrelevant.

The temperature was 97° Fahrenheit, pulse 84, and respiration 26. Leucocyte count was 14,100 with 81 per cent neutrophils. One-half ounce of urine secured by catheterization was negative.

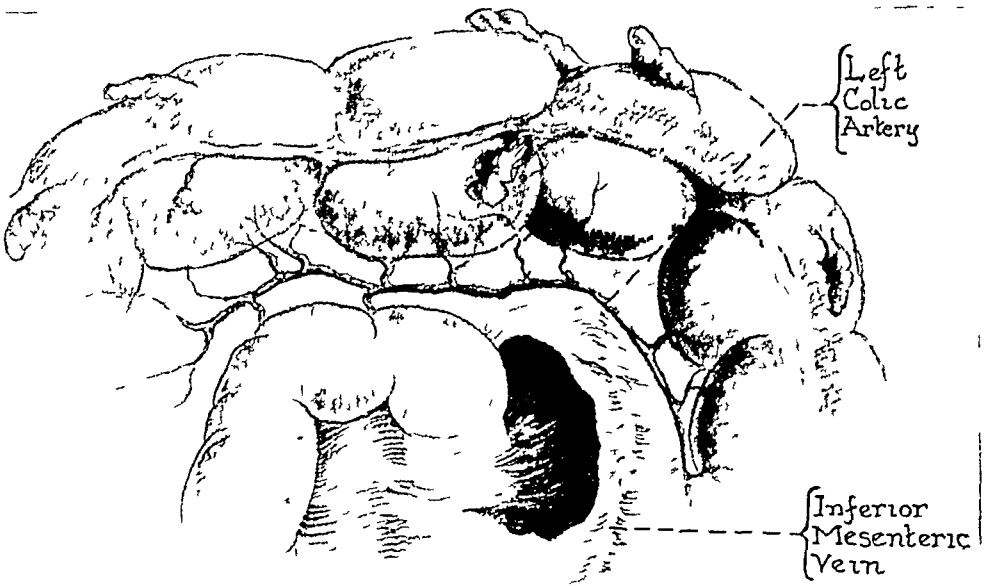


FIG 1.—Paraduodenal fossa (Moyuhon). Case I. Note left colic artery lateral to inferior mesenteric vein, which lies in left and upper falciform edge of fossa.

Physical examination was negative except for a symmetrical tumor, which apparently filled two-thirds of the abdomen. The tumor was smooth and firm and filled the lower abdomen and extended in the mid-line about four centimetres above the umbilicus. There was a dull note upon percussion and the entire abdomen was exquisitely tender. A diagnosis of acute intestinal obstruction of unknown etiology was made. Under ether anaesthesia a long right rectus incision with the umbilicus at its upper third was made. A smooth, symmetrical tumor, which occupied two-thirds of the abdomen and resembled an ordinary ovarian cyst, was found. The inferior pole telescoped the bladder, the omentum was stretched over the tumor and presented a moss-like appearance, the greater curvature of the stomach lay upon the superior pole and the small intestines were not visible, nor could they be seen through the cyst-wall. The cecum was exposed with difficulty but a redundant sigmoid was easily found. The sac was incised and all the small intestines from the jejunum to the lower ileum were found within. Reduction was accomplished by unfolding the root of the mesentery, upon which the hernial orifice was found to be at the duodeno-jejunal junction. Reduction was completed by



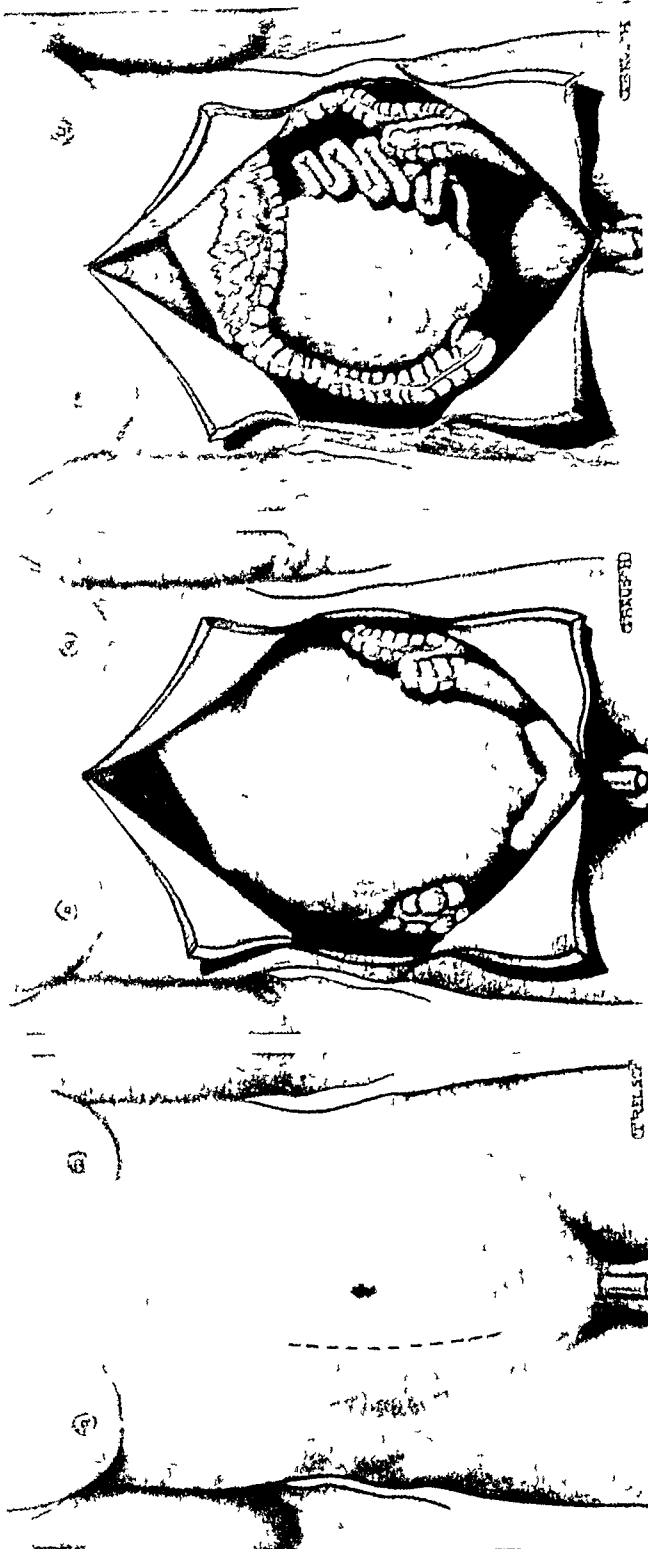


FIG 3

FIG 4

FIG 5

FIG 3—Case I Before incision Symmetrical tumor is clearly shown A slight break in the symmetry of the tumor is found at the left costal margin but is not shown

FIG 4—Case I Operation with recovery but artist has shown wide dissection in order to demonstrate pathology Omentum is shown stretched over tumor, which telescopes the bladder Transverse colon lies posterior to the lower pole

FIG 5—Case II Shows gangrenous terminal ileum outside the sac though the intestine within the sac was viable The gangrene was due to traction upon and consequent thrombosis of the intestinal branches of the superior mesenteric artery The terminal four inches of ileum and cecum were not gangrenous because the ileo colic artery was not thrombosed

# THE RONTGENOGRAPHIC VISUALIZATION OF THE ARTERIES OF THE EXTREMITIES IN PERIPHERAL VASCULAR DISEASE

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IN THE care of vascular disease of the extremities, an accurate pre-operative determination of the state of the circulation should be made. To accomplish this end many tests have been devised to ascertain the influence of vasomotor spasm, the adequacy of the collateral circulation and the patency of the main channels. Recently, in the publications of Brown,<sup>3</sup> White<sup>18</sup> and Morton and Scott,<sup>13</sup> tests for the evaluation of vasomotor overactivity have been suggested. The latter authors have demonstrated<sup>13</sup> the normal vasomotor gradient and the usual level of vasodilatation under given conditions and hence have been able to estimate, in any given case, how much of the peripheral vascular insufficiency is due to vasospasm and how much to organic obliteration.

In the large group of obliterative vascular diseases there have been no safe, exact methods for the determination of the state of the vessels. It is well known that in some of these disorders—for instance, thrombo-angitis obliterans—the main arteries are apt to be occluded and the circulation carried on by the smaller collateral vessels. On the other hand, as is frequently the case in peripheral arteriosclerosis, the smaller arterioles may be obliterated while the larger trunks remain patent. Thus it follows that investigation of the arterial circulation in patients with organic involvement of the vessels should include information concerning not only the main channels, but also the smaller arteriolar branches. This is especially necessary if surgical intervention is contemplated. In the past, many indirect methods have been applied to achieve this end. The condition of the major arteries may be determined by palpation for perceptible pulsation in the vessels, by the application of the Pachon oscillometer or by the use of the recording sphygmomanometer.<sup>14</sup> Occasionally, valuable information is obtained from a plain roentgenogram demonstrating calcification of the vessels, but this gives no indication of the patency of the lumen. The circulation in the arterioles and sub-papillary network of vessels may be judged by the appearance of the part, its temperature, its reaction to elevation or dependency, by the return of the color after blanching, by the absorption of intradermal saline or histamine, by the Moschowitz test or other similar tests. Any one or all of these methods may give valuable information of an indirect nature and some of them should always be included in the routine physical examination of patients with these disorders. For the most part, the methods of physical examination by a competent observer will serve, without the use of special

effect even on the damaged vessel walls. Evidence of thrombosis was never found.

*Animal Experiments*—Before methiodol was injected into patients with vascular disease it was necessary to prove its compatibility with the vessel endothelium and so somewhat higher concentrations were used than is necessary to produce good arteriograms.

Eight experiments were done on dogs. These were designed to determine if possible whether the drug caused irritation of the wall of the artery. A 40 per cent solution of methiodol produced satisfactory arteriograms while a 50 per cent solution was used in all of these experiments to intensify any deleterious effects upon the blood-vessel endothelium. There is, of course, the criticism that the normal vessel may withstand greater concentrations than the diseased but clinical trial has so far been innocuous in our hands.

The following experiments were done: (a) The solution was injected continuously for five minutes into the artery, (b) a segment of artery was isolated, the blood expressed from it, and a loop excluded by rubber-shod clamps. This closed segment was filled with the solution for from one to five minutes before the clamps were removed and the circulation through the segment reestablished. In this way it was felt that the maximum concentration was in contact with the vessel wall for as long as would ever occur in clinical use.

At the end of twenty-four hours and forty-eight hours, the specimens were examined, and sections were taken for histologic study. In no case was there gross or microscopic evidence of thrombosis or injury to the intima.

*Clinical Cases*—Encouraged by the lack of any harmful local action on the vessel wall in the experiments on dogs, it was decided to use the drug in clinical cases of obliterative vascular disease. The drug is dissolved in fresh, glass distilled water, carefully filtered and sterilized by boiling. At first a 50 per cent solution was used but it was later found that a 40 per cent solution was satisfactory and even lower concentrations will serve. The operative method is as follows. Without using a tourniquet, the femoral artery is exposed in Hunter's canal and is separated from the femoral vein and nerve. The cassette containing the film is placed beneath the leg under the drapes and the Rontgen tube centred over the area to be studied. The artery is picked up on a tape and compressed between the thumb and finger to prevent admixture of the solution with blood. The vessel wall is punctured obliquely with a new, sharp, No. 20 gauge needle to which is attached a fifty cubic centimetre syringe containing the methiodol solution. Injection is begun and after about twenty-five cubic centimetres of methiodol have been injected the film is exposed while the solution is still being forced into the artery. The injection is stopped without removing the needle while the film is changed. Then after injecting an additional twenty-five cubic centimetres, the second exposure is obtained while the last five cubic centimetres of the solution are being forced into the artery. After withdrawing the needle the pressure on the artery is released and a moment's pressure with a

there was pallor with elevation and rubor with dependency. The gangrenous areas extended from the first and fifth toes up on to the lateral margins of the foot.

The day after admission, under spinal anesthesia, the femoral artery was injected with seventy cubic centimetres of 50 per cent methiodol solution. The roentgenograms shown in Fig. 1 revealed marked impairment of the arterial circulation. A low thigh amputation was done and the patient had an uneventful convalescence.

CASE II—M. A., No. 45,369. The patient was a sixty-year-old woman, a diabetic, who has had symptoms of vascular insufficiency in the right leg and who developed an ulcer on the right foot seven weeks ago. Four weeks before admission a peri-arterial sympathectomy was done in another hospital without relief of symptoms.

For the past eight years she has known that she had hypertension (systolic blood-pressure ranges from 200 to 280 millimetres of mercury) and two years ago she had a transient hemiplegia. On examination the foot was cold, pulseless, and discolored, with a shiny skin. There was marked muscle atrophy, the nails were hypertrophied, and the color of the foot was markedly changed by a shift in position. There was gangrene of the third and fourth toes involving the web space and extending on to the dorsum of the foot.

Under general anesthesia the femoral artery was injected with sixty cubic centimetres of 50 per cent methiodol. The films showed that all of the major vessels were obliterated and only a few of the smaller collaterals remain. A mid-thigh amputation was done and aside from delayed healing of the stump, the convalescence was uneventful.

CASE III—W. B., No. 33,460. The patient, a seventy-one-year-old man, a diabetic, had a Gritti-Stokes amputation of the right leg for diabetic gangrene a year before the present admission. He now entered the clinic complaining of a cold, painful, discolored left foot. Examination revealed the foot to be a reddish plum color with pigmentation of the skin of the calf. The muscles were atrophic, the skin was dry and glistening, the nails were hypertrophied, the skin was colder than normal and the dorsalis pedis and posterior tibial arteries did not pulsate. The popliteal pulsation was felt and the recording sphygmomanometer showed a normal popliteal pulse.

Under local infiltration anesthesia, the popliteal artery was exposed and thirty cubic centimetres of 50 per cent methiodol injected. The artery was so deep in the wound that a right-angle needle designed for peritonsillar infiltration had to be used. During the course of the injection the patient complained of cramps in the leg which ceased as soon as the injection was discontinued. This was thought to be due to the hypertonicity of the solution.

The roentgenograms revealed only moderate involvement of the arterial tree and a popliteal vein ligation was decided upon and performed.

After operation the color and temperature of the foot improved and pain ceased. At the time of discharge, his condition, to use his own words, "was a lot better." There was no evidence of a harmful effect of the arteriogram and a follow-up examination six weeks after operation revealed continued improvement.

CASE IV—A. R., No. 46,568. The patient was a forty-year-old woman, a diabetic who entered the hospital with gangrene of the foot of two weeks' duration. Examination revealed a toxic, sick woman with gangrene of the first toe and medial side of the foot. There was sclerosis of the peripheral vessels with marked swelling and oedema of the foot and lower calf. The discharge from the affected area was very foul and gas bubbles were demonstrated by roentgenograms.

Immediate operation was done under spinal anesthesia. The femoral artery was exposed in Hunter's canal and injected with thirty cubic centimetres of 50 per cent solution of methiodol. The leg was amputated through the mid-thigh and the wound left open. Convalescence was uneventful. The wound closed by second intention and the bone was covered by drawing down the flaps with skin traction.

The arteriogram (Fig. 2) showed the main vessels and collateral channels to be

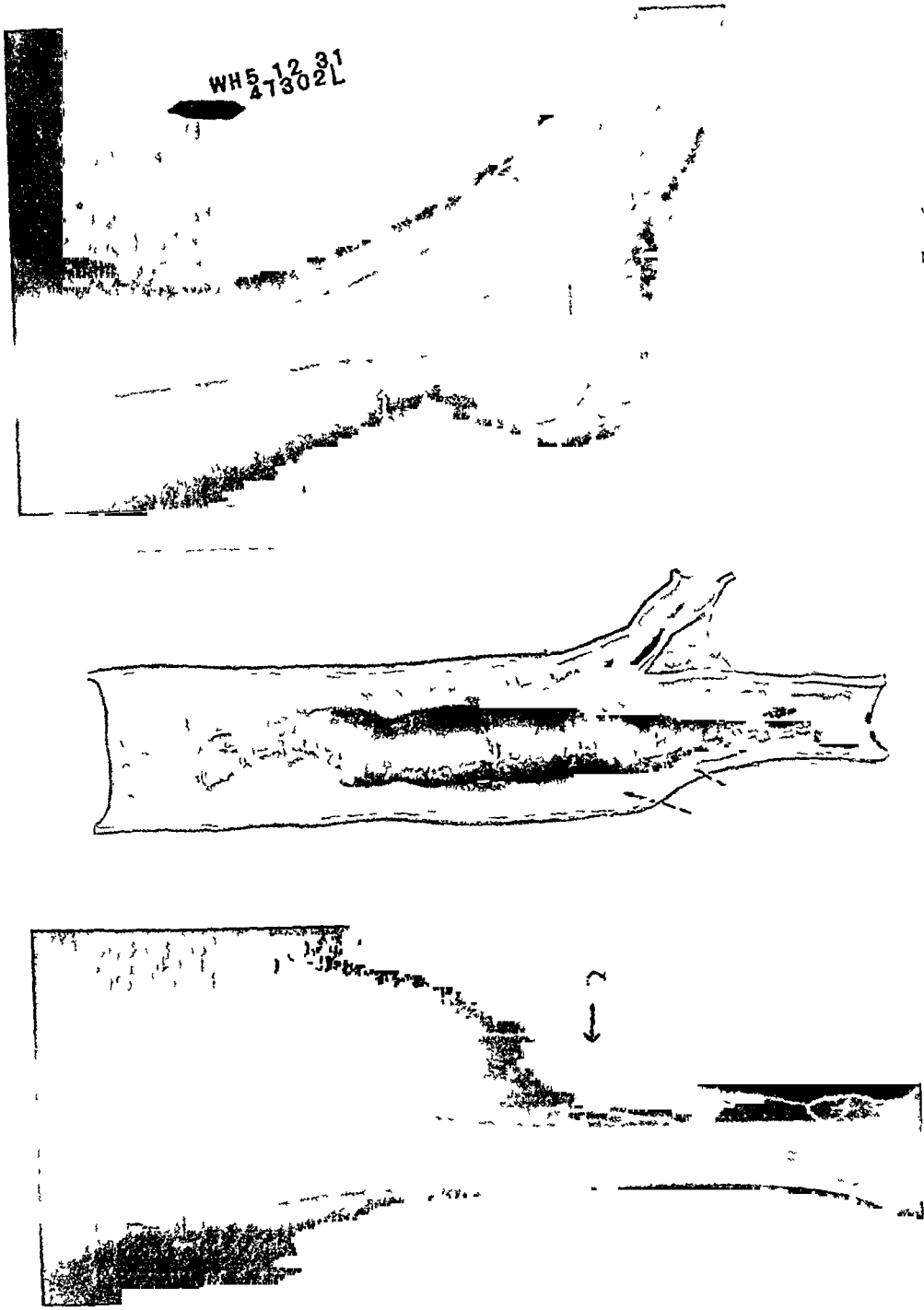


Fig 6

Fig 5

Fig 4

Fig 4—Case VI The popliteal and posterior tibial arteries are obstructed. The anterior artery is occluded at its origin, but is filled by the anterior tibial recurrent artery which connects it with the crural anastomosis about the knee joint (arrow 1) Arrow 2 points to a long anastomotic branch from the femoral artery which fills the posterior tibial at the level of the ankle   
 Fig 5—The location of the embolus in the popliteal artery in Case VI   
 Fig 6—Case VII The arrow points to the obliterated posterior tibial artery The dorsalis pedis and other smaller vessels are well filled

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When I saw the patient, he presented a well-defined dry gangrene of the left thumb with an irregular clear-cut line of demarcation at the level of the interphalangeal joint (Fig 1) There was no sensation in the gangrenous area and needle puncture drew no blood There was an area of marked hyperæsthesia just proximal to the line of demarcation, but there was no evidence of infection X-ray examination was negative, as were also urinalysis, blood sugar, and Wassermann Partial amputation of the thumb was advised, but the patient persistently refused to have this done A spontaneous amputation resulted by the end of August, 1930 Since then the patient has been well

CASE II—Miss J P, aged twenty-nine years, was referred by Dr M L Pinco eleven days after the original injury On February 9, 1931, she accidentally stuck a pin into the right middle finger near the paronychia tissue on the outer side On the following day, severe pain was experienced and she consulted a physician who stated that infection was present and advised incision After placing a rubber-band tourniquet tightly about the base of the finger, he obtained digital nerve block anæsthesia with 1 per cent novocaine injected on both sides A small incision was made and a drop or two of pus was obtained The tourniquet was removed after fifteen minutes On the following day it

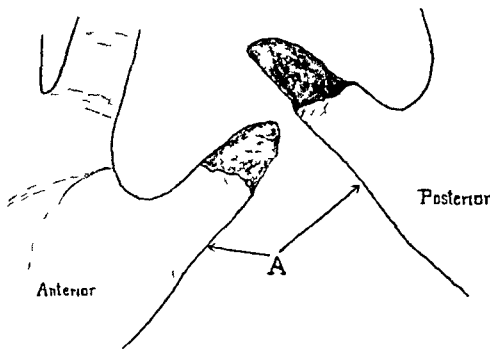


FIG 1

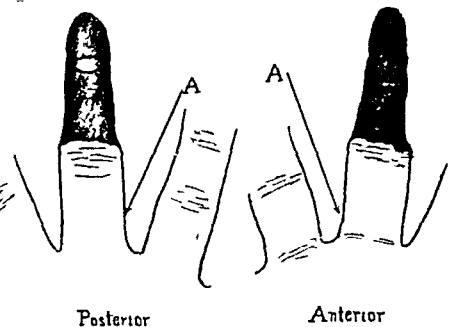


FIG 2

FIG 1—Sketch of condition found in Case I, showing the well defined line of demarcation "A" indicates the approximate site of application of tourniquet

FIG 2—Case II The well defined line of demarcation is indicated "A" marks the site of application of tourniquet

was noted that the distal half of the finger was blue and cold The color became progressively darker during the next few days and the part was anæsthetic

Examination eleven days after the injury showed a symmetrical dry gangrene of the right middle finger with a clear-cut line of demarcation about one-quarter of an inch distal to the proximal interphalangeal joint (Fig 2) The gangrenous area was completely anæsthetic and needle puncture drew no blood All the laboratory examinations were negative

On February 21, 1931, the finger was amputated at the proximal interphalangeal joint The wound was left wide open Healing took place by granulation and was complete by March 28, 1931 She has remained well

Pathological examination of the amputated finger showed thrombosis of the digital vessels The thrombi were apparently well organized The nuclei of the connective tissue cells were very indistinct (Fig 3)

CASE III—W K, aged twenty-nine years, was first seen two weeks after a splinter of wood entered the pulp of the right index finger at its tip An anterior closed space infection apparently developed which was treated with wet dressings for two days, followed by incision without anæsthesia at a hospital As the pain was not relieved, the patient consulted a physician who, after placing a small catheter tightly about the base of the finger, obtained nerve block anæsthesia with 1 per cent novocaine solution by lateral injections An incision was then made The part was then soaked in warm

of the left thumb. The patient immediately went to his doctor who, after much difficulty, removed the foreign body. The operation apparently was performed under strict aseptic precautions. After skin sterilization, a small rubber catheter was placed snugly about the base of the thumb. Digital nerve block anesthesia was obtained by injecting freshly prepared 1 per cent novocaine solution laterally. About 6 cubic centimetres of this solution were used before anesthesia was complete. The operation lasted a little over an hour. Upon removal of the tourniquet, bleeding was moderate. That night, the pain was very severe. On the following day, the end of the thumb was dark blue and anesthetic.

Three days later examination showed a symmetrical dry gangrene of the end of the left thumb with a well-defined line of demarcation at the distal flexion crease (Fig. 5). There was no evidence of infection. General physical examination was negative. Urinalysis, blood examinations and X-ray were negative. Partial amputation was advised and was carried out by the attending physician. Healing took place without incident. Unfortunately, the amputated finger was not preserved.

*Discussion*—It is of interest to speculate as to the exact mechanism behind this unusual occurrence. Each patient was a young adult and presented nothing abnormal on general examination. There was no evidence of arterial disease and all laboratory studies were negative. It would seem, therefore, that the cause was a local one. When the first case was seen, it was thought that, possibly, the novocaine solution had been injected directly into the digital vessels, causing thrombosis. Subsequently, this was considered highly improbable. In no instance was an occlusive dressing used after operation, nor was a carbolic salve applied. In each case, wet dressings of saline boric or magnesium sulphate solution were used and these were not unusually hot.

It will be remembered from the case reports that the attending physician placed a rubber-band or catheter tourniquet *tightly* about the base of the finger before injecting the anæsthetic solution. This would produce two effects, marked local slowing of the blood-stream and local pressure injury to all tissues included in the constricting effect of the tourniquet. I believe that the question of the sterility of the novocaine solution can be answered by the absence of subsequent infection at the site of injection. However, it is probable that the mechanical presence of the solution in the tissues just distal to the point of constriction of the tourniquet was an added factor in the development of the gangrene. Individual idiosyncrasy to novocaine might be considered as a possible etiological factor. However, three of the patients had had previous experiences with novocaine anæsthesia, with no unusual or untoward effects.

After consideration of all the facts, it would seem reasonable to assume that the mechanism of production of the gangrene was as follows. The tight application of a thin tourniquet caused marked local slowing of the blood-stream and tissue injury included in its constricting effect. The latter caused injury to the endothelial lining of the digital vessels, thus favoring thrombosis. The injection of a solution distal to this point constituted an additional mechanical insult, further favoring thrombosis. That all the digital vessels were not involved in each instance is evidenced by the fact that, in



# TRANSACTIONS

OF THE

## NEW YORK SURGICAL SOCIETY

STATED MEETING HELD MAY 13, 1931

### ABDOMINAL HODGKIN'S DISEASE WITH INTESTINAL OBSTRUCTION

DR ALFRED STILLMAN presented a woman, forty-three years of age, who had been suffering for five years with attacks of nausea, vomiting and distention, at first apparently from injudicious eating, but gradually increasing in frequency. Two years ago she had an operation for hæmorrhoids. Eight months before admission to Roosevelt Hospital she had been to St Lukes. Here a Wassermann was 1 plus. She came to Roosevelt Hospital because for five days she had been unable to retain anything on her stomach. She has lost fifty pounds in weight in seven months.

*Physical Examination*—Showed peristaltic waves in lower abdomen. No masses could be felt nor the liver or spleen. Laboratory findings were: Hæmoglobin, 84, red blood-cells, 4,600,000, white blood-cells, 4900 with 76 per cent polymorphonuclears and 24 per cent lymphocytes. Blood-pressure, 114/30. No free hydrochloric acid in gastric test meal. X-ray of chest was normal. X-ray of the intestines showed considerable dilatation of numerous coils of small bowel, suggesting an obstruction of the small bowel. Urine showed sugar twice and red blood-cells twice.

At operation, November 13, 1930, a quantity of clear straw-colored fluid was aspirated from the abdominal cavity and this cultured later a staphylococcus albus. In the small intestinal wall, some few feet from the ileo-cæcal valve, there were several small, whitish masses two to three centimetres in diameter and umbilicated. In the mesentery of these loops was a matted mass of glands very firm in consistency and discolored as by hæmorrhage. The small gut above was dilated and hypertrophied and that below was normal.

One gland was removed for diagnosis. An enteroenterostomy was done between a loop above and one below the obstruction. This operation gave considerable relief but now, six months afterwards, she is again suffering from obstruction. She was presented because the retroperitoneal type of Hodgkin's disease is rare, and obstruction also is not common. The pathologic report was Hodgkin's disease.

### CHOLECYSTENTEROSTOMY FOR OBSTRUCTIVE JAUNDICE

DOCTOR STILLMAN presented a woman, forty-one years of age, who had been suffering from jaundice for five and one-half weeks. She was unable to keep anything on her stomach. The vomitus consisted of gastric contents and no bile. The stools were clay-colored and the urine dark. She complained only of occasional throbbing pain in her right side near the costal margin. She had lost some weight. The liver was not tender, was smooth, and its edge felt three inches below costal margin. Phthalein dye failed to show the outline of the gall-bladder and did not identify gall-stones.

At operation, November 27, 1929, the common duct was found dilated but the gall-bladder contained no palpable stones. A probe passed into an

not in too good a condition. As far as Doctor Cave knew, this was the only instance where a Murphy button had been used to do a choledochoduodenostomy.

DR FREDERIC W BANCROFT said that in doing a cholecystgastrostomy the use of the Murphy button provides a most satisfactory means of doing anastomosis in those cases where it is advantageous in the first forty-eight hours to have a discharge of bile. In bleeding cases, also, it may prevent bleeding around the sutures.

DR WINFIELD SCOTT SCHLEY referred to a case he had ten years ago at St. Luke's Hospital of a woman with marked obstructive jaundice in which exploration showed a small, hard pancreas. The duodenum was near and an anastomosis was made between the gall-bladder and the duodenum. The anastomosis was quickly done using a small button with reinforced gut suture. She passed the button two years later after a sharp attack of pain in upper abdomen. Seven years later she was admitted to the emergency ward with an acute, gangrenous pancreatitis, from which she died. It is surprising that such a small, hard, contracted pancreas could (actively) function for such a length of time, and interesting that she should subsequently develop an acute pancreatitis causing death. She was apparently in excellent health on her visits to the follow-up clinic during these intervening years. Jaundice had entirely cleared following her operation.

DR JOHN DOUGLAS called attention to the sedimentation time instead of the bleeding time in the blood in cases of obstructive jaundice. He said that a disadvantage in the use of the Murphy button was that it might fall into the gall-bladder and the patient subsequently have more pain because of this. This happened in one case of his and there was severe hæmorrhage and the patient died as a result of a second operation. While the Murphy button is expected to go into the stomach, it can fall back into the gall-bladder. Doctor Douglas had one case in which the patient had an abscess between the gall-bladder and the duodenum and came back with severe jaundice after cholecystectomy. It was subsequently necessary to do a lateral anastomosis by the suture method between the common duct and duodenum. If there is a large dilated duct there is no difficulty in making the anastomosis between the duodenum and the common duct. In regard to the question of dissecting out the sinus and inserting it into the stomach, one should never try to dissect the sinus beyond the liver margin, for if one tries to dissect it away from the edge of the liver one always gets into the sinus.

DOCTOR STILLMAN rejoined that, so far as he knew, the sedimentation test was not used at the Roosevelt Hospital. The clotting and bleeding time of jaundice cases are taken and when these are prolonged calcium chloride is given. In the case under discussion anastomosis to the stomach seemed simpler because of the deep position of the duodenum. It was done by the ordinary suture method. In those cases where severe bleeding is

bled the cellular arrangement in a rubber sponge. There was no blood in it, but only clear fluid and Doctor Erdman assumed it to be angioma. The mother insists on the prenatal origin of this "birth-mark" and recounts while pregnant with this child, she, the mother, was hit on the inner side of the thigh with a pear which caused a black and blue spot and believed at the time this would mark her child, and, sure enough, when the child was born a similarly situated mark was found.

#### ANATOMIC TUBERCLE OF THE THUMB

DR GUILFORD S DUDLEY presented a man, twenty-eight years of age, a pathologist. He has always been quite well and gives no past history of infection by or susceptibility to tuberculosis. It has been his custom to perform autopsies with bare hands.

On September 30, 1930, he inflicted an incised wound about one quarter of an inch in length upon the skin of the dorsal aspect of his left thumb at the level of the metacarpo-phalangeal articulation. This accident occurred while sectioning a lung extensively diseased by caseous tuberculosis. The wound bled freely, was washed at once with running water, later was bathed with alcohol, and the incident dismissed from his mind. Primary union took place, but by October 5, 1930, a slightly raised erythematous area about three-eighths of an inch in diameter had appeared at the site of the injury. By October 10, 1930, this papular lesion seemed fully formed and showed a very small, superficially ulcerated zone at its central point. An occasional droplet of serous fluid appeared from this ulcer but at no time was there any evidence of active secondary infection. There was no pain, no adenitis, and no systemic symptom. Early in November, 1930, the lesion was treated by two therapeutic exposures to the X-ray. Following the second treatment the area of redness increased slightly in size but, in a few days, returned to its original condition.

On November 25, 1930, the lesion was excised under the pre-operative diagnosis of anatomic tubercle. This was performed under novocaine infiltration anaesthesia and, at the time, it was thought that the excision had been sufficiently wide to assure a complete cure. The skin edges were approximated under moderate tension and primary union took place throughout except at the distal extremity of the scar. At this point there developed an indurated papule about one-eighth of an inch in diameter, and, as in the instance of the first lesion, superficially ulcerated at its central point. After more than two months' unsuccessful treatment with the quartz mercury lamp, the second attempt at operative cure was undertaken. On March 1, 1931, under nitrous-oxide anaesthesia, the recurrent tubercle was excised widely and the defect covered with a full-thickness skin graft taken from the upper arm. This procedure was successful and the region involved is now healed completely.

Histologic examination of the first tubercle showed all the characteristics of an epithelioid tubercle without caseation. In addition, tubercle bacilli were found in a specially stained section. The second specimen also showed typical Langhans giant cells in an epithelioid tubercle without caseation. Tubercle bacilli were not found in this section.

DOCTOR DUDLEY also presented a second patient, a man, who is serving an internship in a hospital. It has been and still is his custom to perform autopsies with bare hands. His past and family history are completely negative for tuberculosis. In September, 1930, solely as a matter of interest, he

## CHRONIC OSTEOMYELITIS OF THE TIBIA

DOCTOR DUDLEY presented a woman, twenty-eight years of age, who was admitted to the Second Surgical Division of Bellevue Hospital, April 30, 1931, complaining of pain and swelling of the right leg. She stated that an enlargement in the region of the right ankle, which seemed to vary in size from time to time, was first noticed about eighteen months before but that not until twelve months later did she suffer from any pain. This pain was situated in the upper third of the leg and accompanying it there appeared a swelling in this region. Since then this swelling has extended progressively to involve practically the entire leg, and motion at the knee-joint has become restricted. Although pain was one of her complaints upon admission, this symptom has not been a prominent feature and is present only upon walking. She gave no history of chills or fever and to her knowledge has had no previous illness which would throw any light upon her present condition. She had been told that a blood test taken elsewhere about six months ago was reported to be negative. She has had but one pregnancy and this terminated spontaneously at two months. She has gained twenty pounds in weight during the past year. There is a diffuse enlargement of the entire right lower leg from the knee to the ankle, particularly marked in the upper half. Many superficial distended venules are seen within the skin on the anterior aspect of the lower half and slight oedema in the region of the ankle. Tenderness to pressure was only of moderate degree, but was more pronounced in the upper half of the leg. Profuse perspiration was present on the entire leg but not on other surfaces of the body. Upon palpation the swelling was of bony, hard consistency and apparently caused by involvement of the tibia. Extension of the leg at the knee-joint was restricted slightly. A few firm lymphatic glands were palpable in both inguinal regions. General physical examination showed a somewhat highly arched palate and slightly unequal pupils which reacted promptly to light and accommodation but no other stigmata of congenital lues. Temperature, pulse and respiration were normal.

The laboratory reported 4,200,000 red blood-cells with 50 per cent of hæmoglobin and marked central achromia of the cells. White blood-cells were 10,000 with 74 per cent of polymorphonuclears. Urinalysis was normal (no Bence-Jones protein). The Wasseimann reaction was four plus.

The X-ray department reported chronic osteomyelitis of the entire shaft of the tibia with bony sclerosis and periosteal thickening extending to and involving the lower end of the corresponding femur. Radiographic examinations of the remaining long bones, the skull, and the thorax were negative. Since then discussion has centred about the probability of luetic osteo-periostitis and the decision to test the result of anti-luetic treatment has been reached.

She is presented to the society because of the interest attached to the diagnosis.

DR LEON T LEWALD said that his impression was that this condition is not osteomyelitis, as he believed it lacked the classical signs, as far as the X-ray was concerned. Involvement of the lower end of the femur is not distinct in the X-ray film, but provided there is such involvement it might well be due to a secondary metastatic lesion. He recalled a similar case in a young woman in whom there was complete swelling of the leg from the knee down. It looked like osteomyelitis but lacked the characteristics of this

## BRIEF COMMUNICATIONS

### HEAD OF FIBULA IN HIGH AMPUTATIONS OF LEG

THE remarks of Doctor Marks, in the ANNALS OF SURGERY, May, 1931, vol xciii, p 1118, regarding the disposition of the head of the fibula in high amputations of the leg suggest the following practical points

The removal of the fibular head makes a smooth and conical shaped stump, prevents the secondary pain and disturbance caused by the bone end. It also permits the operator to resect the external popliteal nerve (and inject it with alcohol) at a higher level, thus obviating some of the chances of amputation neuroma and its sequences

Objections to the removal of the head of the fibula are

It involves more cutting and a more prolonged operation

In removing the head the operator may (a) cut into the knee-joint unknowingly, or (b) connect the amputation wound into the knee-joint by opening the bursa about the head of the bone and the interosseous membrane. This bursa may connect by a small passage or be a real accessory pocket of the knee-joint itself

Should the amputation be elective and aseptic no untoward result may follow. If the amputation is one of urgency, as many *high* amputations are, or if they concern infected tissues, or tissues devitalized which may slough or become infected, the fibula head had best be left *in situ* to guard against infection spreading into the knee-joint. I have seen several such unhappy infections and their sequences after removal of the head of the fibula in septic and potentially septic legs in civil practice and also in those encountered a few years ago in France and Belgium

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### THE PRODUCTION OF PEPTIC ULCER AFTER SECTION OF THE GASTRIC NERVE

THIS study was made with the purpose of determining if sectioning the nerves to the stomach in any way modified the development of peptic ulcer produced by a standardized method. It seems reasonable to assume, from what has been written on the function of the vagus nerves and splanchnic nerves in relation to the physiological processes of the stomach, that these nerves might be significant in the development of ulcer, particularly since Durante<sup>3</sup> was able to produce superficial ulcers in rabbits by merely dividing these nerves. Carlson<sup>2</sup> stated that combined section of the vagus nerves and splanchnic nerves results practically in permanent hypotonus of the stomach except under conditions of prolonged starvation. Alvarez<sup>1</sup> has

## BRIEF COMMUNICATIONS

Briefly, the results were the development of a typical peptic ulcer in each experiment, except in one in which the vagus nerves had been sectioned

Section of nerves to the stomach did not prevent the development of ulcer in that portion of the intestines which received the gastric content after measures had been taken to drain the duodenal secretion away from that region

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## STRANGULATED EPIPLOIC APPENDIX SIMULATING APPENDICITIS

TORSION of the epiploic appendix giving rise to acute abdominal symptoms may be easily confused with acute appendicitis In more than 50 per cent of the cases reviewed by Johansson, the diagnosis of acute appendicitis was made, in no case was the correct diagnosis made before operation The case reported here is of interest because of the rarity of the condition, and because it is the result of true torsion, the meso-appendix being involved secondarily

A woman, aged thirty-three years, was admitted to hospital June 6, 1931, because of pain in the right lower quadrant of the abdomen The pain had not been severe as a rule, and was relieved by rest in bed for a few hours She had never had any acute attacks of abdominal pain associated with nausea or vomiting She had been constipated and occasionally some pain in the right side was associated with defecation A diagnosis of chronic recurrent appendicitis was made

June 9, 1931, the abdomen was explored The uterus and adnexa were normal The gall-bladder felt normal and did not contain stones The appendix, however, was long and was attached to a tumor about two centimetres in diameter low in the pelvis The tumor was the result of a twisted epiploic appendix of the sigmoid, circulation to it was completely cut off The tumor was attached to the sigmoid by a thin pedicle about one and one-quarter centimetres long and was removed without difficulty The appendix also was removed

In the cases generally referred to under the term intra-abdominal torsion, it is not so easy to understand the interference with circulation. Payr has suggested that disproportion between the artery and vein is the cause. Occasionally the epiploic appendix has been found twisted one or more times on its pedicle. Necrosis of its pedicle may occur and the appendix drops off, and remains a foreign body in the peritoneal cavity. There are twelve of these cases on record. These cases, however, are not of especial clinical interest, the condition is usually found during laparotomy for some other condition.

Two other types of torsion may occur which are of more clinical significance. Gradual interference with the blood supply may result in a chronic inflammatory mass and this may become attached to the omentum or as in the case reported the appendix forms a potential means of mechanical intestinal obstruction.

In still another type the epiploic appendix becomes distended with fluid but retains its attachment to the colon. Cystic masses about 5 centimetres in diameter have been reported as retaining their attachment to the colon by long pedicles. These may or may not become inflamed. Sometimes most acute abdominal symptoms may arise necessitating immediate operation.

The diagnosis is extremely difficult. In none of the twenty cases of torsion necessitating immediate operation, reviewed by Johansson was the diagnosis made pre-operatively. Appendicitis is the most common diagnosis.

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#### EDITORIAL ADDRESS

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## DIVERTICULITIS OF COLON

This case was placed in Group A—acute diverticulitis without perforation or complication

CASE XXVI—W T, male, thirty years of age, was admitted to the hospital February 16, 1927, with a three-day history of pain across the lower abdomen. The attack started with a sharp sticking pain in the left lower quadrant and was accompanied by vomiting. Twenty-four hours later the pain radiated across the lower abdomen to the right side. He had been constipated since the onset of the attack. Physical examination was quite negative except for some pain and tenderness across the lower abdomen.

Laparotomy disclosed numerous diverticula in the descending and the sigmoid colon. Appendectomy performed. Exploration of the other viscera was negative.

Post-operative course was uneventful until the eighth day after operation when he was stricken with a sudden sharp pain in the right side of his chest and his temperature went to 102°. During the next two days he spat up some blood-streaked sputum. The temperature returned to normal on the thirteenth post-operative day. He was allowed home on the sixteenth day after operation.

This case was placed in Group A—acute diverticulitis without perforation or complication.

CASE XXVII—V N, female, thirty-five years of age, was admitted to the hospital on three occasions. Her first admission was January 22, 1925, at which time an appendectomy with drainage was performed for an acute appendicitis. Her second admission was in June, 1925, when a right salpingectomy was performed for tuberculous salpingitis. Her third admission was in January, 1928, at which time a hernioplasty was performed for the repair of a ventral (incisional) hernia. At the time of her second admission a barium enema was taken and the report stated that the sigmoid was considerably elongated and that there was some saw-toothed appearance in the upper portion of the sigmoid which suggested an early diverticulitis.

This case was placed in Group B—chronic diverticulitis without perforation or complication.

CASE XXVIII—J S, female, sixty-three years of age, was admitted to the hospital May 31, 1925, with typical history of biliary colic. Her past history was quite negative except for an appendectomy performed in 1901. A barium enema was given and the plates were reported as showing the lumen of the descending colon to be saw-toothed in appearance owing to the presence of diverticula.

This case was classified in Group B—chronic diverticulitis without complication or perforation.

CASE XXIX—S S, female, fifty-one years of age, was admitted to the hospital March 14, 1926, with a vague gastro-intestinal history of having had attacks of fullness and flatulence associated with a definite feeling of distress but without any real pain or cramps. Physical examination was essentially negative.

A gastro-intestinal barium series was completed and at the twenty-four-hour period the caput of the cæcum was still filled and the appendix irregularly outlined. There are in the sigmoid a number of rounded shadows irregularly filled with barium indicating diverticula.

This case was placed in Group B—chronic diverticulitis without perforation or complication.

CASE XXX—W B, male, fifty-two years of age, was admitted to the hospital March 19, 1916, with the history of increasing constipation of two and a half years' duration. Previously the bowel movements were regular but the stools small. With a diet and the use of mild cathartics he was afforded some temporary relief. For the past month he has had attacks of vague cramp-like pain across the lower abdomen and more especially in the left lower quadrant. He also states that his abdomen has increased in size. Physical examination is essentially negative except for some slight tenderness in the left lower abdominal quadrant.



*Laparotomy Performed*—The upper part of the sigmoid for about four inches was markedly thickened and hard and the mesocolon infiltrated with hard nodules. The entire large bowel as far back as the cæcum was markedly thickened and distended. Resection of the sigmoid with subsequent anastomosis of the distal portion of the bowel to the cæcum. Drain inserted to the site. Convalescence entirely satisfactory.

Pathologic report (Path No 19,727) was diverticulitis of the sigmoid colon with stricture of the colon. Grossly, the specimen consists of a portion of the sigmoid colon about fifteen centimetres opened longitudinally. A little above the middle of its length is a constriction, and at this point the bowel measures four centimetres in inner circumference, the normal circumference being about ten centimetres. In the middle of the constricted part is a narrow opening that leads into a narrow diverticulum. Microscopic examination of the diverticulum wall shows it to be lined with granulation tissue that is infiltrated with numerous plasma round cells, eosinophiles and in some places



FIG 8



FIG 9

FIG 8—Radiograph of Case XXXII. Chronic diverticulitis without perforation or complication. Film No. 80 203 shows a large number of diverticula filled with barium in the course of the descending and sigmoid colon.

FIG 9—Radiograph from Case XXXIV. Chronic diverticulitis without perforation or complication. Treatment was conservative. Barium enema reported (No. 96 957) that the colon filled completely but from the junction of recto sigmoid upward to the lower descending colon there is a narrowing and irregularity of this region. The bowel is quite sawtoothed and suggests an early diverticulitis.

many polymorphonuclear leucocytes. The section of the sub-mucous tissues taken at the point of constriction shows similar inflammatory changes.

This case was placed in Group E—diverticulitis with stenosis.

CASE XXXI—H K, male, fifty-two years of age, was admitted to the hospital July 17, 1917, with a vague gastro-intestinal history. Full details were not obtained.

*Laparotomy Performed*—At operation there was a mass the size of a walnut found in the wall of the descending colon. Two loops of small intestine were found to be adherent to the mass and were freed. The mass was excised and the defect repaired. Cigarette drain placed to the site.

Pathologic report (Path No 21,470) stated diverticulitis of the descending colon. Microscopic sections show a portion of the mucosa with evidences of a catarrhal inflammation. round-cell infiltration of the sub-mucosa, muscularis and the adjacent fat tissue.

This case was placed in Group D—chronic perforated diverticulitis with abscess.

## DIVERTICULITIS OF COLON

CASE XXXII—D S, male, sixty-seven years of age, was admitted to the hospital December 17, 1925, with a rather indefinite history of flatulence and attacks of indigestion of seven months' duration. He stated that for the past seven months he had, on occasion, been constipated but did not relate his present feeling of weakness to that factor. He appeared a chronically ill man, with some enlargement of the liver and some loss of weight. Examination otherwise negative.

Routine barium enema showed that in the course of the descending and sigmoid colon there were a large number of diverticula filled with barium. (See Fig 8.)

This case was placed in the Group B—chronic diverticulitis without perforation or complication.

CASE XXXIII—M L, female, fifty-three years of age, was admitted to the hospital in May, 1925, with the complaint of generalized abdominal cramps of two weeks' duration. Onset of her illness was rather vague in character and was accompanied with some flatulence and constipation. Physical examination was quite unsatisfactory owing to the obesity of the patient, though in the left lower quadrant of the abdomen there was some tenderness. Barium enema disclosed a diverticulitis of the sigmoid with a filling defect similar to that produced by a carcinoma.

*Laparotomy Performed*—On opening the abdomen, the sigmoid and uterus presented as a single mass. Necrotic tissue was encountered to the left of the sigmoid in a cavity about two inches in diameter. No radical procedure was deemed advisable and a drain was placed at the site of the abscess cavity.

Her convalescence was entirely satisfactory and she was discharged from the hospital.

She returned to the hospital one year later and a follow-up barium enema was taken at that time (May 28, 1926). This was reported as diverticulitis of the sigmoid. There is no filling defect to be found in the sigmoid though there is still some spasm of the sigmoid present.

This case was placed in Group D—chronic perforative diverticulitis with abscess.

CASE XXXIV—H O, female, forty-two years of age, was admitted to the hospital June 1, 1925, with a history of attacks of lower abdominal pain associated with some flatulence of five years' duration. She states that she has never passed any blood in her stools nor has she ever been constipated. There is slight tenderness in the right lower quadrant of the abdomen.

Barium enema showed the sigmoid passed to the left and was situated just beneath the crest of the ilium. It was elongated and redundant and took a transverse course to the right iliac fossa where it joined the descending colon. In the course of the sigmoid and the descending colon were several diverticula visualized by the enema. The cæcum was large and not fixed.

Laparotomy with appendectomy. Post-operative course entirely satisfactory. She was discharged on her eleventh day after operation.

She was seen at the follow-up clinic October 4, 1925, and the note made that her condition was excellent, scar was healed, firm and painless. She had to take a cathartic every two or three days. Had no complaints.

This case was placed in Group B—chronic diverticulitis without perforation or complication.

CASE XXXV—G L, male, thirty-six years of age, was admitted to the hospital December 21, 1926, with the complaint of pain in the hypogastrium and in the region of the umbilicus of four weeks' duration. The pain was not localized but seemed to radiate to his hips and was accompanied by some tenesmus. He at no time passed any blood. Physical examination negative except for a mass said to have been felt above the prostate in the posterior rectal wall and seemingly attached to the sacrum.

Barium enema revealed the colon filled normally and completely but from the junction of the rectum and sigmoid upward to the lower descending colon, a definite

narrowing and irregularity of this portion. Area quite saw-toothed and is characteristic of an early diverticulitis (Fig 9)

This case was placed in Group B—chronic diverticulitis without perforation or complication

CASE XXXVI—E W, female, forty-three years of age, was admitted to the hospital May 25, 1927, for the first time, with the complaint of pain and the presence of a palpable tumor in the lower abdomen just above the pubis. She stated that for the two-weeks interval preceding her entrance to the hospital she had noted a fullness in the lower abdomen associated with some burning pain at the site of the fullness. She had not been constipated but had had the sensation of incomplete evacuation following her bowel movements. Attacks of flatulence on occasion. A mobile mass could be felt in the suprapubic region.

*Laparotomy Performed*—Operation revealed, in addition to multiple fibroids of the uterus, a perforating tumor of the sigmoid. This mass occupied the lower portion of the sigmoid flexure and was adherent to the parietal peritoneum. There was also a partial constriction of the sigmoidal lumen. There were no perceptible surrounding lymph-node involvements. A supravaginal hysterectomy and a first-stage Miculicz' operation were performed. Five days later (May 31, 1927), the second stage of the Miculicz' operation was done.

Her post-operative course was stormy. A posterior colpotomy was required for the evacuation of a collection of purulent material in the cul-de-sac of Douglas. A transfusion of 500 cubic centimetres of whole blood was given. Anti-luetic treatment was also instituted. She was allowed home on the forty-third post-operative day and was to return at a later date for the closure of the intestinal fistula (Third-stage Miculicz').

Re-admitted to the hospital three months later (August 2, 1927) at which time a closure of the draining fistula was performed. Subsequently the fistula re-opened and she was allowed home on the twenty-second day after operation. She was seen in the follow-up clinic October 15, 1927. Her condition was very satisfactory. The fistula had not closed but the discharge was constantly decreasing in amount and she was having normal bowel movements. She reported again in December, 1927, as being in excellent health. Had gained in weight. Sinus was not completely closed. Condition satisfactory.

Pathologic report (Path No 35958) was Chronic perforation of the sigmoid colon. Grossly, the specimen consists of a short segment of colon, the wall of which is infiltrated with hæmorrhage. There is also some inflammatory reaction in the fat. Microscopic examination revealed ulceration and inflammatory reaction in wall of the gut and in the surrounding fat.

This case was placed in Group D—chronic perforative diverticulitis with abscess formation.

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# BACTERIOPHAGE IN SURGERY OF THE COLON AND RECTUM

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ACKNOWLEDGING a certain susceptibility to the contagious enthusiasm of d'Herelle for the clinical application of bacteriophagy, and having been inoculated in listening to d'Herelle's Lane Medical Lectures in 1928, we have looked to the bacteriophage with some degree of hope as a possible resort in some of the terrible problems of infection that every now and then confront the surgeon

We are fortunate in having in Stanford University a so-called Bacteriophage Research Laboratory, of which Professor E W Schultz is director. Part of the research work of the laboratory is in the application of bacteriophagy in the field of clinical medicine, and the laboratory offers its services in determining the susceptibility to lysis of bacterial cultures sent by physicians

The various kinds of bacteria in the culture are plated and each kind of bacterium is inoculated with a drop of bouillon suspension of a number of phages known to cause lysis of bacteria of the same sort and note made of the particular ones which cause most active lysis of the culture and a suspension of this particular phage or group of phages is furnished the clinician. For this service a nominal charge is made to assist in the support of the laboratory

One reads in the literature such enthusiastic reports of clinical response to treatment by bacteriophage in so wide a variety of infections that if one belongs to the more confiding portions of the medical profession he is tempted to look to bacteriophage almost as a panacea for all bacterial ills, and yet when one talks with his friends he hears such discouraging reports and learns that one after another has given it up after conscientious trial that he wonders just where the virtue and truth lie. Is it blind enthusiasm on the one hand or faulty technic on the other? Before essaying a final verdict and although the burden of proof is on the advocate of any new therapeutic measure, the critic can have no standing in court until he can show that his errors of technic have been eliminated

We are told that in certain diseases, *e g*, cholera, bacteriophage therapy is almost specific. At least, d'Herelle would claim almost 100 per cent, others (witness reports from Egypt from British sources) would assign a very much smaller percentage. However, a strong case is made out for the value of bacteriophage therapy. Yet, in other affections, the very contrary obtains

Under these circumstances, items of individual experience, no matter how modest, may become useful contributions

One important field in surgery in which there is great need for some effective anti-bacterial agent is the surgery of the colon, because of the high mortality of operations on the large intestine, especially as compared to the risk of similar operations on the stomach and small intestine. In addition to circulatory and mechanical peculiarities, the difference is due largely to the fact that in the stomach and small intestine the bacteria in their contents are ordinarily in a relatively attenuated culture, while in the large intestine the bacteria are not only more numerous and of greater variety of sorts, but also more active. Given this suggestive explanation the problem is how to lessen the virulence of the bacteria of the contents of the colon and rectum.

Earlier and more accurate diagnosis and more rational preparation before operation, getting rid of bloody and mucoid contents by judicious catharsis, as well as improved operative technic, have materially lessened the mortality in operations on the colon and rectum, but there is still much to be desired. The mortality is still too high and in patients who survive operation, convalescence is often outrageously long.

Seriously complicating is the fact that in the large bowel, in addition to the great variety of aerobic bacteria ordinarily inhabiting the large bowel, there are often anaerobes occasionally of exceedingly virulent sorts. While the Welch *Bacillus*, e.g., may in pure culture or in certain combinations be comparatively innocent, in combination with resistant strains of colon *Bacilli* or active streptococci, it increases the risk enormously—as in the following case.

A powerful middle-aged man, a fireman, woke early one morning, as he said, with "his piles hurting him." In fourteen hours a streak of black, gangrenous, gas-filled tissue extended from the anus to the left axilla with gangrene of scrotum and penis, death in forty-eight hours in spite of incision from one end to the other of the discolored area. The atrium of infection was a small ulcer in the anus.

Again, in the case of a young woman who in an automobile accident, after having both legs broken—fractures compound—landed in a sitting position on a boulder in a creek bed. The right ischium cut through the skin and was broken. The open wound was beside the anus and when patient arrived at hospital twenty-four hours later, the wound was found to be black and to contain gas of characteristic odor. The Welch *Bacillus* was recovered. The obviously gangrenous tissue was excised, the wound irrigated with peroxide of hydrogen and painted with mercurochrome, this followed by subcutaneous injection of Mulford's poly-anaerobic antitoxin given subcutaneously and 100 cubic centimetres in 500 of salt solution intravenously. The patient recovered.

Whether it is established or not that the people of India who bathe in the Ganges and drink of the waters live by virtue of the destruction and attenuation of the bacteria by the multifarious bacteriophages with which the sacred waters abound—whether bacteriophage deserves the credit for the survival of the human race through the centuries before the practice of what we call sanitation—or whether bacteriophage is the answer to an American lady on a boat on a Holland canal witnessing the emptying and washing of pots-de-chambre and milk pans and the family linen in the

workers of the canal who remarked that "the canals of Holland would seem altogether to disprove the germ theory of disease," there is much promise that a rational administration of bacteriophage may be useful—even effective—in controlling infection with the bacteria of the colon

But the problem of bacteriophage therapy is not as simple as one might suppose. It is not enough to take any phage and administer it to the sick man by mouth or hypodermically or locally. To be effective the phage must fit; it must be "matched," i. e. be shown to cause lysis in the particular culture and strain of bacteria in point. One great defect, therefore, in the practical application of bacteriophagy to clinical problems, is the time required to seek out by trial in the laboratory an active phage for the particular case, for in many such as they occur clinically delay is disastrous.

Then d'Herelle and others have demonstrated that not only do different phages exhibit different degrees of activity, but the individual phage may lose its potency, or on the other hand it may have its potency increased at will by replanting in suitable bacterial cultures.

Again, since most bacteriophages known have been isolated from the intestinal contents or from sewage, it may be taken for granted that any individual phage has been living in the intestinal contents in symbiosis with the bacteria—developing, then, a sort of mutual relation with potency so adjusted to the resistance of the particular strain of bacteria as to set up a sort of balance so that the bacteria are kept in check but not destroyed. Moreover, the bacteria by long association with bacteriophage of perhaps low virulence have acquired new resistance to the activity of the phage. There are individual cultures of common bacteria, even strains of otherwise susceptible cultures which are strongly resistant to bacteriophage.

All this is true to an almost unbelievable extent in relation to the colon *Bacillus*—if one can speak of "the" colon *Bacillus*—a matter which is of supreme importance when attempting to control colon *Bacillus* infections in surgical operations either in prophylaxis or after wound infection has occurred.

Much of the practical difficulty in therapeutic use of bacteriophage and particularly in colon infections is the fact that time is often of supreme importance: witness the perforated appendix, perforation, operative or otherwise in diverticulitis—where the delay of three or four days necessary to procure a matched phage may be fatal—a circumstance which not only seriously limits the clinical value of bacteriophage therapy, but would seem to relegate it to the field of chronic colon *Bacillus* infections. But here it would seem to be of distinct value, *e. g.*, in chronic, even ulcerative colitis.

In acute infections, then, if treatment by bacteriophage is to be attempted, we are obliged to resort to blind application of mixtures of phages which have shown themselves active in causing lysis in a variety of strains of the colon *Bacillus* in the hope that one of them may "fit."

While, therefore, there is the possibility that a suitable phage may be

found for a particular case, other proven methods of treatment must be used just as if bacteriophage had not been discovered

If bacteriophage has been used together with other means of treatment and the infection is overcome, one is, of course, in doubt as to what beneficial effect, if any, is due to the activity of the phage. In other words most of the clinical phenomena which may be ascribed to the activity of bacteriophage are often brought about by other means, such as evacuation of abscesses, drainage, the use of mercurochrome solutions, *etc.* It requires, therefore, an immense volume of such clinical evidence properly to estimate the credit due the phage.

It is well known that strains of colon *Bacillus* vary greatly in their susceptibility to lysis by particular bacteriophages even from one extreme to the other, some being so resistant that no phage in such a large collection as is kept alive in the Stanford Bacteriophage Research Laboratory will cause any degree of lysis.

On the other hand, not only do different phages vary in their activity in causing lysis of the same strain of colon *Bacillus*, but even an individual phage may be most erratic in its behavior—*e g.*, failing to cause lysis of a particular strain or strains of colon *Bacilli*, but effective in causing lysis in distantly related or even unrelated bacteria.

Carcinoma of the colon and rectum is not only the most frequent and most serious disease of the large intestine, but it embodies most, if not all, the bacteriologic phenomena which obtain to a lesser degree in practically all other diseases of this organ which are susceptible to surgical attack, so that, if the problems of the operation for cancer can be solved and the operation be made safe, the same technic will solve the problem of other less serious morbid processes.

The mortality of the operation of excision of carcinoma of rectum and sigmoid is high but if the patient survives the operation he has a good chance to escape recurrence and remain well, for the simple reason that adenocarcinoma of the intestine ordinarily metastasizes slowly.

Barring then, the occurrence of metastasis before operation, excision cures in a larger percentage of cases than in carcinoma of other organs. Cure, therefore, of carcinoma of the colon and rectum by operation is largely a matter of technic. The great danger is infection, for there is no reliable means of resecting the colon without some degree of soiling.

In carcinoma of the colon and other ulcerative conditions, perhaps with bleeding and with obstruction, a great variety of organisms may find suitable living conditions and have their virulence so increased as to furnish a most serious danger. It is for this reason that in carcinoma, for example, modern technic requires complete emptying of the intestine before operation is undertaken, often impossible without preliminary colostomy or cæcostomy (preferable in many cases).

One of the worst complications is the presence of virulent streptococci against which there are few active bacteriophages.



When one receives from the laboratory a suspension of bacteriophage, what is it that is delivered? Actually it is a quantity of bouillon in which bacteria have been grown and bacteriophage added, which phage is supposed to have, and ordinarily has destroyed all the bacteria. To guard against possible failure of complete lysis of the bacteria in the culture, and to prevent the application to the wound or hypodermically of virulent organisms, the broth is passed through a Chamberlain filter which normally catches bacteria but passes the smaller bacteriophage. It is conceivable that there is here a danger from the occasional inefficiency of the Chamberlain filter. This danger is known to be small, but it may be real.

Phage suspensions therefore, before use should be limpid clear and before delivery a portion of the batch should be centrifuged and examined, even cultured, for the presence of bacteria.

The vehicle, broth, originally contains a certain amount of proteid, and unless this proteid is entirely destroyed (it usually is), it may give rise to proteid shock or anaphylactic phenomena which, in a patient weakened by sepsis, may be serious. Therefore, only small amounts may be injected subcutaneously, 2 to 3 centimetres, and the intravenous use, justified only in desperate conditions, but there most dangerous for the reasons stated, would best be avoided until the problem has been more completely worked out.

In a case recently reported by a colleague, that of a child suffering from serious staphylococcal osteomyelitis, after repeated intravenous injections of phage suspension the child recovered and the osteomyelitis speedily cleared but the injections were followed by shock and rise of temperature to 106° F so one wonders as to the safety of the procedure.

Because of the variation in activity of bacteriophage in relation to the variety and strain of bacteria, results may be expected only from the more active strains of bacteriophage and experience bears this out. Moreover, experience shows that bacteriophage notwithstanding its extreme penetrating capacity, is more reliable when administered in considerable amounts locally than when given subcutaneously.

And again the effect is often only temporary. Perhaps not enough emphasis has been placed on the value of repetition of the administration at not too long intervals until recovery.

The following cases, too few to warrant conclusions, are nevertheless suggestive.

CASE I—A N, aged sixteen. *Acute perforating appendicitis, wound infection, pelvic abscess.* Six days after operation drainage of foul pus. Leucocytes 21,000 to 25,000, 90 per cent polymorphonuclears. One cubic centimetre suspension of stock bacteriophage known to be active against colon *Bacilli* injected into the arm, four cubic centimetres, into the peritoneal cavity between adherent coils of intestine. Two days later pelvic abscess was opened in left groin evacuating 500 cubic centimetres of thin foul pus, mixed culture of *B. coli* and non-hemolytic streptococci. Drainage profuse and continuing. Four cubic centimetres of matched bacteriophage (anti-colon bacillus phage) injected into wound. In forty-eight hours drainage markedly less, odor notably

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less, the change too marked and too rapid not to warrant at least some credit being given to the phage

CASE II—W M, a man aged fifty-three, *perforative appendicitis* Leucocytes 21,200, 87 per cent polymorphonuclears, with localized abscess January 14, 1930, drainage, evacuating 6 ounces of very muddy pus January 24, rise of temperature to 103°, pulse 110, leucocytes 30,000, 82 per cent polymorphonuclears Large pelvic abscess opened suprapubically Drainage continued Culture showed Gram-positive cocci, pure growth of staphylococcus albus February 15 matched bacteriophage injected 1 cubic centimetre in arm, 2 cubic centimetres into wound, followed by slight rise of temperature Thereafter highest temperature was 37.2° C Drainage rapidly ceased It seemed that the bacteriophage had pretty definitely had a favorable influence on the wound No further abscess developed

CASE III—H, aged sixty-two A small *carcinoma of the rectum*, too small to have produced obstruction Apparently a most favorable case for cure February 13, 1930, operation, colostomy and local excision of the rectum by combined abdominal and perineal route Exploration of the abdomen showed two tiny nodules on the posterior surface of the liver, inaccessible for removal for histologic purposes Annoying infection of the abdominal wound occurred Culture made Culture showed mixed growth of *B. Coli* and staphylococcus aureus, the former predominating In the bacteriophage research laboratory *B. coli* in several varieties determined by their sugar reactions were isolated and a variety of other bacteria, Gram-positive cocci and Gram-negative bacilli February 20, seven days after operation, 1 cubic centimetre in deltoid, 4 cubic centimetres in rectal wound, of polyvalent anti-*B. coli* phage Two hours later several chill with sharp rise of temperature for a few hours Temperature thereafter normal Convalescence normal—at least there was no further inflammatory trouble March 7, matched anti-*B. coli* bacteriophage 5 cubic centimetres instilled into wound March 8, ditto Notwithstanding perforation at the suture line in the hollow of the sacrum, the wound healed without serious inflammation March 25, 1931, operation for closure of the colostomy permitted a second abdominal exploration The liver being found to contain many metastases, the colostomy was not closed

CASE IV—P D, age sixty-three *Carcinoma of the sigmoid colon with complete obstruction*, no bowel movement for nine days Preliminary colostomy February 14, 1930, tumor removed, end-to-end anastomosis, normal wound healing March 4 operation for closure of the colostomy Gut freed, closed with two rows of linen sutures with additional safety sutures of chromicized catgut Region of suture line in intestine painted with mercurochrome Three days later wound broke down, had to be opened Five cubic centimetres matched anti-colon phage suspension instilled into wound, slight chill, temperature to 102° F for a few hours March 8 ditto, not followed by reaction It was difficult to assign any very definite effect to the bacteriophage Convalescence protracted but now, a year after operation, patient is enjoying robust health

CASE V—P M, a fat man of fifty *Acute diverticulitis*, not ruptured June 28, 1929, an immense ventral hernia on the right side of abdomen repaired Through a large McBurney incision on left side a tumor mass in the mesentery of the sigmoid was exposed near the brim of the pelvis It was impossible to draw the mass up into the wound Since there was no perforation, no peritonitis, nothing suggestive of carcinoma, no tumors in liver, cigarette drains were introduced to the region of the mesenteric tumor and led out of the incision July 1 abscess broke spontaneously and discharged through the abdominal wound Culture showed many bacteria of various types including Gram-negative bacilli of the *B. coli* group as well as long chains of streptococci, large Gram-positive bacilli and Gram-positive cocci in pairs The colon bacilli seemed to be most numerous July 8, patient was deeply septic, leucocytes 15,000 to 21,000, 82 per cent polymorphonuclears, irrational at times, frequent liquid stools, discharge continued foul

July 12 matched bacteriophage (anti-*B. coli*) 1 cubic centimetre injected hypo-

dermically in arm, 4 cubic centimetres instilled into wound. A few hours later the temperature which had averaged between  $99\frac{1}{2}^{\circ}$  and  $100\frac{1}{2}^{\circ}$  for a week, rose to  $102^{\circ}$  on two successive evenings, and thereafter slowly subsided.

July 17 bacteriophage 5 cubic centimetres instilled into wound. This was followed by a similar rise of temperature for three nights after which the fever subsided and remained normal. The phage used was stock-pooled coli phages Nos 1 and 2 of the Stanford Laboratory which on first two passages gave but incomplete lysis. On the third passage the lysis was complete. It was this filtrate that was injected. The discharge rapidly ceased, patient was out of bed five days later. August 5 left hospital. The recovery was so prompt after the injection of the phage that it seemed more than evident that the phage deserved much credit.

CASE VI—V T, age seventy-one. *An immense abscess filling pelvis and lower abdomen.* X-ray examination impossible because barium could not be induced to pass beyond the rectum. Temperature normal, leucocytes 9,000, November 13, 1930. Operation evacuating more than a litre of four mucopurulent material, probably due to slow perforation of a diverticulum although carcinoma could not be excluded. Culture gave only a few Gram-negative bacilli. Culture showed *B. Coli*. Lysis was complete with polyvalent anti-coli bacteriophage mixture No 18 of the Stanford Laboratory. November 18 and 19 2 cubic centimetres of this phage suspension were injected hypodermically, several cubic centimetres instilled into the wound. Slight rise of temperature  $100\frac{1}{2}$  for two days. There was a very marked and almost immediate change in the character of the discharge. In particular the foul odor almost completely was destroyed. Four days later, however, there was again a rise of temperature and pulse rate. Otherwise than the change in the discharge there was no assignable effect of the phage. Liver or subphrenic abscess developed, patient became deeply septic in spite of further opening and drainage. Patient gradually went down and died February 18, 1931. The phage was used once or twice subsequently towards the end of the illness. In this case it would seem that the phage was not given a fair trial. It should have been used many times instead of twice early in the illness.

CASE VII—G T, aged fifty-seven. Immensely fat. *An acute diverticulitic abscess in the mesentery.* December 27, 1928, operation by another surgeon showed abscess size of a hen's egg in the mesentery of the sigmoid. Next day the abscess was opened and the intestine opened also, as in colostomy. Three months later an attempt made to close the colostomy. The wound broke down.

March 23 stock phage, not matched, instilled into wound. No noticeable effect. March 28 pus containing a variety of bacteria *B. coli* were isolated. *B. coli* phages were tested but gave only partial lysis. Complete lysis was given by a phage recently isolated from sewage. Matched phage 2 cubic centimetres intradeltoid. Some instilled into the wound. No noticeable effect. The colostomy remained open and two and a half years later a second attempt was made to close it. It might have been well to have made culture from the patient's intestinal contents isolating the principal bacteria and to have tried to have found phages which would be active against them. However, having on hand a quantity of anti-*B. coli* phage from the previous case (Mrs V T) several cubic centimetres of this were poured into the wound before closure. A fulminating infection followed. A gangrenous streak the width of one's hand rapidly formed and led from the wound around the flank as far as the mid-line. Culture showed a variety of organisms, *B. coli* and non-hemolytic streptococci predominating. The latter failed to grow on sub-cultures, no Gram-negative bacilli were found suggesting anaerobes, nor was there growth in anaerobic culture. Cultures of the *B. coli* were subjected to the polyvalent anti-coli mixtures. There was no lysis of any culture, the bacteria being completely resistant to the phage. There seemed no use, therefore, in administering the phage at this time. In spite of wide incision, the gangrenous process extended and patient succumbed sixteen days after the operation.

This case brought up the interesting question as to whether the colon bacilli had

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become resistant to bacteriophage because of the inoculation of the phage two years before. This seems unlikely, but one does not know.

These cases, being but seven, are useful merely as illustration of the difficulties of administration of bacteriophage therapy in *B. coli* infections rather than of any very positive or beneficial effect. In several of them it seemed only fair to give the phage some of the credit for the clinical improvement which followed quickly upon its administration, such as changes in the character of the discharge, lessening of odor, *etc.* In the other cases the phage completely failed as far as our observations could go. In nearly all of the cases the administration of the phage was followed by a temporary rise of temperature repeated next evening. The cases which showed most marked improvement were of sufficiently long duration to be classed as chronic. One cannot say that in any of the cases a life was saved by the phage, but it is very clear that it utterly failed in two, in one after some favorable promise, the other because of the infection with a phage-resistant bacterium, nothing could be expected from bacteriophage therapy. Still, it must be acknowledged that in none of these cases was bacteriophage therapy given a really fair clinical trial. None, *e g.*, had the administration repeated often enough to get full or lasting effects.

The question of the use of bacteriophage in prophylaxis preliminary to resections of the colon needs investigation. It is conceivable that matched phages found to cause lysis of cultures of the intestinal bacteria in the case in which it is proposed to remove the colon, *e g.*, in carcinoma, might be prepared before hand and used at the time of operation, being applied directly to the suture line of the intestine as well as by mouth before operation and intramuscularly. In several cases I have instilled bacteriophage suspensions into the free peritoneum in the region of an intestinal suture line and in none did peritonitis follow. Of course, in such use, or hypodermically or especially intravenously, only phage suspensions which have been tested for the presence of bacteria, and to the eye are absolutely clear, may be used.

## DIVERTICULITIS AND SIGMOIDITIS

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THESE two conditions are secondary to the presence of diverticuli in the wall of the sigmoid, so-called diverticulosis. A distinction is made because in some patients no gross diverticuli are visible, either by X-ray or on the operating table, and one finds only a thick-walled, red, oedematous sigmoid. Nevertheless the same etiologic factor is present in both.

Diverticulosis of the sigmoid and colon is usually looked upon as a rather innocuous condition to which little attention has to be paid. It is considered to be interesting rather than important. The etiology of the condition has aroused a great deal of curiosity and various explanations have been offered for their origin. That they are acquired false diverticuli seems well established. They increase in frequency as age advances, most of them being observed between fifty and seventy. It seems to be some change in the wall of the gut, perhaps due to stretching of a weakened muscular wall which allows these small bud-like projections to prolapse. As long as they empty regularly they produce no symptoms at all, or at most a slight feeling of fulness and discomfort with gas distension. Stagnation, however, may easily occur in these little pockets and it is this which makes them visible on Röntgen-ray films (Fig. 1). In case this stagnated material becomes putrefactive and causes irritation a group of symptoms is initiated which require medical or surgical attention. It is this class of patients with which this paper is concerned.

Although diverticuli may be present along the entire course of the colon usually only those in the sigmoid produce symptoms. This is probably due to the narrow lumen and the frequency of stagnation at this point. In what proportion of cases, with acquired diverticuli of the colon and sigmoid pathologic changes occur which produce symptoms, is difficult to say, largely because we have no accurate statistics as to the frequency of diverticulosis. In some hospitals it has been observed much more often than in others. Haines<sup>1</sup> states that during the year 1925 one case of acute diverticulitis with perforation was observed in the Cincinnati General Hospital and that during the years 1915-1925 two cases with diverticulosis were found at autopsy. Since he states that the hospital admits 10,000 cases annually, of which number 20 per cent are surgical, this records only three cases in 20,000 patients. Newton<sup>2</sup> on the other hand reports forty-four cases of proved instances of diverticulosis and diverticulitis in 56,000 cases admitted to the Peter Bent Brigham Hospital, Boston, over a period of fourteen years. This means one case in about 1,300 patients. William J. Mayo<sup>3</sup> states that records at his clinic show a total of 2,139 cases of diverticulosis. Among 31,838 X-ray

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examinations of the colon for general diagnostic purposes, 1,819 cases showed diverticuli, or 57.1 per cent. Of the 2,139 recorded cases of diverticulosis, active diverticulitis was present in 696 at the time the patients were examined. Doctor Mayo is of the opinion that in about 12 per cent of the cases with diverticulosis acute diverticulitis will develop. As to throwing some light on the frequency of diverticulitis as compared with carcinoma of the sigmoid, it may be stated that during the same period in which 696 cases of diverticulitis were observed at the clinic, there were 2,354 cases with carcinoma of the sigmoid.



FIG 1.—Large palpable tumor in case of diverticulitis which subsided spontaneously. Observed during two attacks at intervals of four years.

Depending on the degree of involvement of the affected portion of sigmoid, the symptoms may vary from irritation to the most severe degrees of inflammation or obstruction. The symptoms are not due to the mere presence of diverticuli, but to complications associated with them. Impaction alone will give rise to painful spasm, retention of gas, perhaps constipation or diarrhoea. Continued impaction will lead to ulceration and infection and may result in perisigmoiditis. Although the infection will usually empty through the lumen of the diverticulum into the gut, it may perforate exter-

nally and lead to abscess formation or peritonitis. It may dissect between the layers of the wall of the sigmoid until a large segment becomes involved forming a palpable tumor. Frequently, adhesions are formed to the abdominal wall, the bladder, or loops of small intestines, and these may lead to perforation into one or the other viscus with resulting internal fistulæ. At times the blood-vessels of the wall may become thrombosed, resulting in necrosis with perforation, or a pyelophlebitis may extend to the liver. The cellulitis of the wall of the sigmoid itself may lead to obstructive symptoms or adhesions of surrounding loops of gut may produce angulation and obstruction. There is no limit to the serious surgical complications which may result from acute sigmoiditis or diverticulitis.

It is possible to divide the cases clinically according to the pathologic changes and the course they are following into

- 1 Simple diverticulitis and peridiverticulitis which subsides without operation
- 2 Diverticulitis with complications resulting from perforation such as abscess, gangrene, peritonitis and fistulæ
- 3 Diverticulitis resulting in intestinal obstruction
- 4 Diverticulitis associated with carcinoma

The patients belonging to group one are in a way the more interesting from a diagnostic standpoint. The symptoms may be mild or they may be so severe as to be alarming. Some of these patients complain only of pain over the left lower abdomen, sometimes abdominal cramps, gas distension, a feeling of spasm, with associated constipation perhaps alternating with diarrhoea. They are not acutely ill. On examination one may find some tenderness along the sigmoid, but nothing else. In other patients the pain may be sharp in character and shoot through the lower left abdomen, and one may find considerable tenderness over that region. Then there is a group of cases in which the symptoms are more distinctly of an inflammatory nature. The pain may be very severe, the patients sometimes state they feel as if they are going to die. A condition of shock may be present. There is definite tenderness and rigidity over the left lower abdomen and frequently in the suprapubic region. There is a rise of temperature, perhaps to 100° or 101°, and blood examination shows leucocytosis. Cramps, vomiting, and urinary symptoms may be present. Very often there is a palpable tumor which may extend upward as far as the umbilicus and may be mistaken for an ovarian cyst or tubo-ovarian disease. If the symptoms have persisted for some time, there may be loss of weight. Bleeding or discharge is uncommon. If present, it may suggest carcinoma. Experience has shown that carcinoma is not often associated with diverticulitis, but nevertheless it has to be borne in mind. A history of recurrent attacks rather than a steadily progressive one, as usually found in carcinoma, will help one in reaching a correct diagnosis.

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In the more severe complicated cases the clinical picture may be very confusing. In the acute surgical emergencies, which not infrequently present themselves in the form of a perforation or obstruction, the diagnosis may be suspected but may not be made until the abdomen has been opened. In the less acute cases on the other hand the history, the symptoms and physical signs, and the X-ray may point the way to a correct diagnosis.

X-ray examinations are of the greatest value. One may use a test meal or a barium clyster. Sometimes one sometimes the other, gives the better pictures. Frequently the best outline of diverticuli is obtained after evacuation of a barium clyster. (Fig 2) At times the changes in the sigmoid are

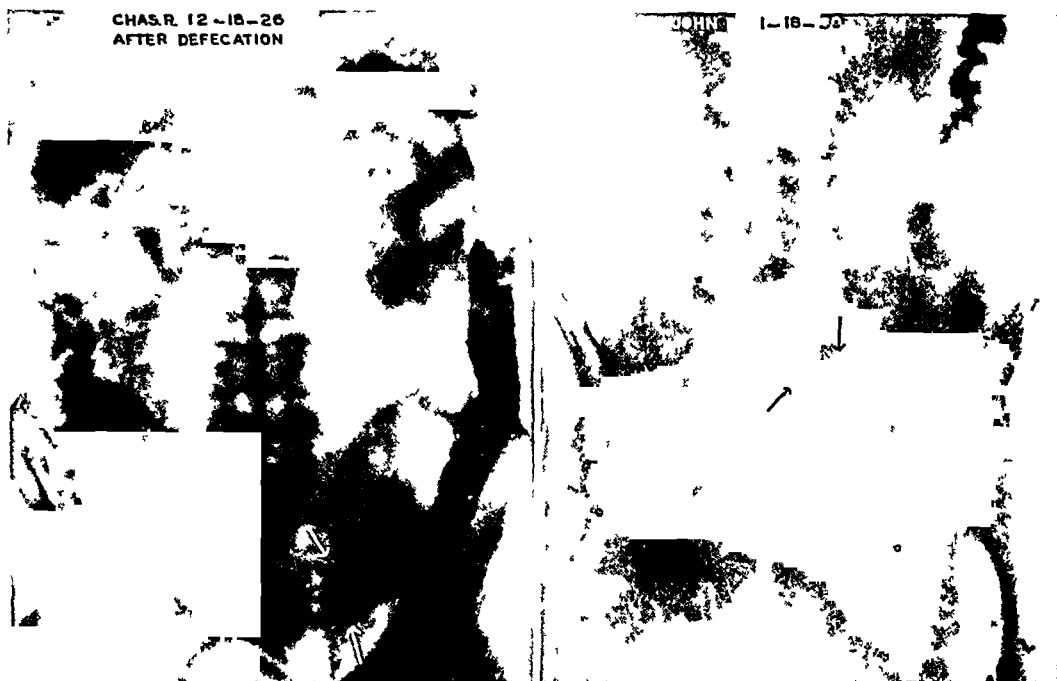


FIG 2

FIG 3

FIG 2—Showing multiple diverticula in an acute case after evacuation of the barium. Perforated once and later had to be resected.

FIG 3—Patient admitted with diagnosis of carcinoma of sigmoid. History and presence of one diverticulum close to defect aided in the correct diagnosis of sigmoiditis. Was not operated on.

difficult to interpret. During the acute stage of the disease it is frequently not the presence of well-filled diverticuli which attracts attention, but rather a narrowing of the lumen with spasm and irregular filling defect. Carcinoma may be suspected and may be difficult to rule out. The presence of a diverticulum close to the lesion or of diverticuli in other portions of the colon may indicate the underlying lesion. (Fig 3)

*Report of Cases*—This paper is based on twenty-four personally observed cases in all of which the symptoms were sufficiently severe to require surgical consultation. Some have been under observation for many years, while others are of more recent date. Several patients have had only one acute attack which subsided under medical treatment while others have been seen several times with recurrent attacks. After a long period of observation



several of these patients finally had to be operated on, while still others were admitted as surgical emergencies and had to be operated on at once

All patients were over forty years of age, only five being between forty and fifty, seven between fifty and sixty, nine between sixty and seventy, and three over seventy

There were thirteen men and eleven women in this group

It may be of interest to note that the majority belonged to the rather well-to-do class, twenty being private and only four ward patients. There was, however, nothing in their method of living which could be held responsible for the development of symptoms. Adiposity does not seem to be a factor

*Symptoms and Physical Signs*—In order of frequency the following symptoms and physical signs were noted

1 Pain	24 patients	8 Vomiting	9 patients
2 Fever	18 patients	9 Obstruction	8 patients
3 Constipation	14 patients	10 Perforation	7 patients
4 Palpable Tumor	11 patients	11 Urinary Symptom	6 patients
5 Cramps	11 patients	12 Loss of Weight	6 patients
6 Leucocytosis	10 patients	13 Diarrhœa	6 patients
7 Gas	10 patients	14 Bleeding	6 patients

1 Pain was complained of by all and was usually the outstanding symptom for which surgical aid was sought. It varied a great deal from steady pain situated in the left lower quadrant to cramp-like pain associated with incomplete or complete obstruction. It naturally varied with the existing pathological changes. In ordinary uncomplicated sigmoiditis or diverticulitis with thickening of the wall of the gut, and perhaps a palpable tumor, the pain may not be bad, but it may be extremely severe, cramp-like in character and associated with symptoms of shock. Patients sometimes feel as if they are going to die. The clinical picture is an interesting and alarming one, and after having been seen several times will aid one in the diagnosis in favor of sigmoiditis rather than tumor. The pain is apparently due to an intense spasm of a segment of gut. If perisigmoiditis develops or a perforation takes place with resulting abscess or peritonitis, pain and soreness due to the involved peritoneum may become more evident.

2 Temperatures over 99° were considered fever. Six patients had between 99° and 100°, while twelve had over 100°. In the uncomplicated cases the fever usually varied between 100° and 101°, while in those with complications it reached 103°–104°, or even 105°. The higher degrees were usually found in patients with perisigmoiditis, or peritonitis and abscess formation, but it is interesting to note that in two patients with very high fever continuing for weeks no peritonitis was present. There was an extensive infiltration of the wall of the gut which in one of them had extended to the bladder wall, the mesentery and the abdominal wall. All cultures from the tumor bed, from the involved lymph-nodes and from inflamed appendices epiploica were negative, and no organisms were seen in the smear. One

probably has to assume the presence of a phlegmon in the wall of the gut which eventually perforates into the lumen. We were able to prove the presence of such intra-mural abscesses in two of our cases in which a resection was done (Fig 4)

3 Constipation is a common complaint of older people and its significance in this condition is not always apparent. At times it seems as if constipation and the associated straining at stool may be one of the causes of diverticulosis. Certainly constipation and the attendant impaction of faecal



FIG 4—Showing multiple diverticulæ of descending colon and sigmoid. Perforated and had local abscess in the wall of the gut

material in diverticulæ may precipitate an attack. During an acute attack constipation may become a prominent symptom and may suggest obstruction. It was noted in fourteen of the twenty-four patients.

4 In several patients a thickened tender sigmoid could be felt, and in nine of the twenty-four cases there was a definite palpable tumor. In several patients this tumor was quite large and in two it extended upward as far as the umbilicus. A diagnosis of ovarian cyst or tubo-ovarian disease is made not infrequently. It is the associated intestinal symptoms and an X-ray examination after a barium clysma which clears up the diagnosis. Of great

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interest is the rapidity with which a large, tender mass may subside under best treatment, external applications and careful rectal irrigations (Fig 1) In case perforation takes place with abscess formation, drainage may be established

5 Cramps may be very severe and are often aggravated by taking a laxative They are due to spasm of the affected portion of gut, or to intestinal contractions resulting from an obstructive lesion Those due to spasm seem to be the most painful



FIG 5—Gelatinous carcinoma in the presence of multiple diverticula Complete obstruction had resulted Resection was done

6 Leucocytosis is frequently found, especially in patients with fever It may be unusually high, with a high polymorphonuclear count The higher counts have not been an indication of the presence of pus, but have been found in patients in whom prompt subsidence of symptoms occurred after a few days without abscess formation The highest count reported was 48,800 with 90 per cent polymorphonuclears, which was verified by having it repeated This patient was operated on while she had a temperature of 103° No pus was found but there was an extensive cellulitis of the wall

of the sigmoid, with involvement of the mesentery, urinary bladder and abdominal wall. All cultures were negative. She eventually recovered without any evidence of having had an abscess. One may assume the presence of an intra-mural abscess which evacuated into the lumen of the gut.

7 Associated with constipation there is frequently retention of gas with discomfort, distension and gurgling. Sometimes it is felt to stick on the left side. In seven of our patients this symptom became an important one. Inability to pass gas is of as much significance in this condition as it is in

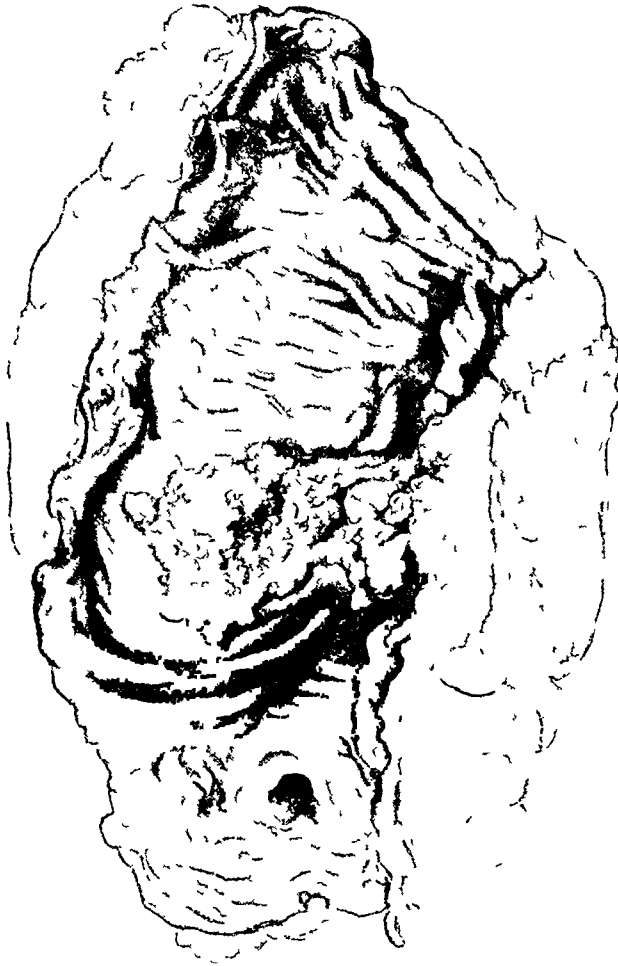


FIG. 6—Gelatinous carcinoma developing around a large diverticulum. Later perforated and formed a local abscess.

other forms of obstruction. In one of our patients with acute perforation into the free abdominal cavity, there was enormous distension with a sensation as if he were blowing up.

8 Vomiting occurred in all the patients with complete obstruction as well as in several of those inflammatory cases presenting a palpable tumor. The proper evaluation of this symptom is important, whether it indicate obstruction or be reflex in character, for on that depends in some measure whether an operation is to be performed or the patient treated conservatively.

9 Obstruction may occur and may be incomplete or complete. It may be due to the mass itself which, by thickening of the wall and hyperplasia associated with the inflammation, brings about an incomplete or complete obstruction, or it may be due to angulation of loops of small gut which have become adherent to the inflamed sigmoid.

In five of our cases, obstructive symptoms were partly due to adhesions angulating loops of small gut. They could be separated and that element of the obstruction relieved. In one of them a portion of small gut had to be resected. In another there were two separate obstructions, one resulting from the sigmoid mass, the other from angulated small intestines. The diagnosis of the two conditions could be made before operation. Four patients had incomplete obstruction due to the mass itself, and five had complete obstruction. In two of the latter the pathological examination revealed an associated carcinoma (Figs 5 and 6).

10 Perforation took place in seven patients. In three there was local abscess formation. In two of these the abscess was plastered against the wall of the gut and could be lifted out with the tumor mass, while in the third case a large abscess developed which contained pus and gas and had to be opened externally.

In four patients an acute perforation took place into the free peritoneal cavity. One of them was drained early and recovered, another was treated expectantly for peritonitis without knowledge at that time of the underlying cause, and finally recovered, while the other two died.

11 Urinary symptoms were present in six patients. Whether in each case these symptoms had any definite relation to the sigmoiditis is not possible to state. In one female patient the bladder wall was definitely involved, but no perforation had occurred. In another female patient there were extensive peritoneal adhesions involving also the bladder. The other patients were men, in whom the prostate may have played some role. In one male patient, however, the symptoms were sufficiently severe to suggest calculus, and X-ray examination with catheterization of ureters was done to rule that out. In another old patient a diagnosis of carcinoma of the sigmoid with perforation into the bladder had been made, but examination showed the colon lesion to be a sigmoiditis, and the bladder affection a cystitis secondary to the sigmoiditis.

12 Loss of weight was a factor in only a few cases in whom long-continued inflammation with associated digestive disturbances or an associated carcinoma were responsible.

13 Diarrhoea was not a common symptom and was never severe. In some patients it alternated with periods of constipation.

14 Bleeding. In six patients gross blood had been noticed from time to time. Whether in all cases it had its source at the site of the sigmoid lesion could not be definitely determined.

In one patient a gangrenous inflammation of the sigmoid with vessel changes was present.

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In another, a carcinoma was found, and in a third there was intense congestion of the mucosa. In these cases no doubt the bleeding came from the lesion, while in the others it may have come from hæmorrhoids.

Bleeding is not an important symptom and if present should make one think of a complication or an associated carcinoma.

In several patients a proctoscopy was done, but no diagnosis of sigmoiditis was made by means of it.

*Bacteriology*—Some attempts have been made to gain information about the organisms responsible for the infection. There have been no uniform results. In two very sick patients with high fever and most extensive infiltra-



FIG 7—Irregular filling defect due to acute sigmoiditis. Had exploratory operation done. Perforated a year later and formed a large abscess.

tion of the wall of the gut (in whom cultures were made from the peritoneum, from small areas of localized abscess due to breaking down of tissue, or from involved lymph-nodes), all reports were negative. The explanation probably is a small suppurative focus in the wall of the gut with extensive cellulitis spreading from there.

In two patients with peritonitis, due to acute perforation, streptococci and colon bacilli were isolated. A large abscess containing pus and gas in another case yielded *Bacilli coli communior*.

Gram-positive bacilli and cocci were observed in the stained section from the wall of a very acute case showing gangrene and perforation.

In another patient, in whom a resection was done, *Bacilli enteritidis* was isolated from a small abscess in the wall. No anaerobic organisms were found. Gram-positive cocci were found in the stained-tissue sections.

*Course of the Disease*—Of the twenty-four cases reported, eleven have so far not been operated on. Several of them had only one acute attack which subsided with appropriate medical treatment while a few have been under observation several times.

At the time of discharge all of these patients were informed of the pathological condition underlying their complaint and they were made familiar with the measures calculated to avoid recurrence, such as the use of mineral

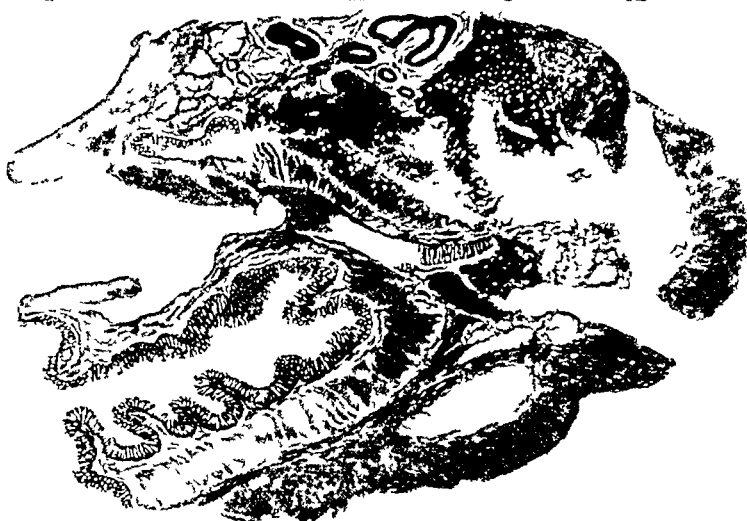


FIG 8—Cross section of colon ( $\times 20$ ). The larger lumen is that of the gut. Above it is an acute abscess (in a diverticulum) the walls of which are partially lined by intestinal mucosa. The remaining portions of the mucosa have been destroyed by the suppurative process.

oil to insure a daily evacuation, avoidance of food with a large residue, and avoidance of overeating. That these measures apparently have some success is evidenced by the fact that most patients have remained free from recurrence. On the other hand, the recurrences have shown that there is no positive safeguard in avoiding acute sigmoiditis or diverticulitis in those patients afflicted with diverticulosis. The condition must be considered a serious one and one must be prepared at any time to see a recurrence or a complication requiring surgical intervention.

In thirteen of the twenty-four patients some kind of surgical interference was indicated or became imperative. Some of these patients had been under observation for a long time and were known to have diverticulosis, while others were seen for the first time during the acute surgical emergency.

*Treatment*—Patients with temperatures under  $100^{\circ}$  and those with no fever at all were treated ambulatorily. They were put on a light diet with little residue, and mineral oil was ordered for morning and evening. Rectal irrigations were given when indicated and perhaps local applications of heat

All the more acute cases were put to bed. They were carefully observed for evidence of perforation. Aside from fluid diet, and perhaps a little mineral oil *per os*, nothing was ordered until a definite diagnosis could be made. A blood count was done. As soon as it was considered safe, an X-ray was taken, occasionally after a bismuth meal, but usually after a barium clysma, given carefully to avoid excessive pressure. With rest, perhaps application of an icebag or heat, and with careful rectal irrigations the acute symptoms would usually subside in a few days and the patient become ambulatory. It is interesting to observe how quickly a large mass may disappear. In case there was unusual delay the reason for that was looked for. In a few cases X-ray treatment was apparently of value in aiding the dissolution of the mass. If local complications developed, an operation was indicated.

When surgical treatment was undertaken it was always for a definite indication, either for recurrent attacks, for abscess formation, for acute perforation, for incomplete or complete obstruction, or on the suspicion that one might be dealing with a carcinoma.

In six of the thirteen cases operated on, the operation was deliberately planned after sufficient observation leading to a correct diagnosis, while in the other seven cases operation was done for a surgical emergency, either acute perforation or obstruction.

The nature of the surgical procedure depended on the conditions found. Frequently several procedures had to be combined to meet the demands. Freeing of adhesions, two cases, drainage—perhaps with freeing of adhesions, six cases, colostomy, seven cases, cæcostomy, two cases, resection of small intestines, one case, resection of sigmoid, six cases.

The simplest operation was separation of adhesions with freeing of the sigmoid in two patients in both of whom there was a suspicion of carcinoma. In six patients drainage alone was instituted for abscess or for acute perforation, or the tumor mass was freed out of its bed and drainage then instituted. Colostomy was performed seven times. In only one patient did it become necessary to establish a permanent colostomy, while in the others it was a temporary measure. A cæcostomy was done twice, in both patients it remained permanently as a safety valve. One of these is living. He has normal evacuations but keeps the cæcostomy with a tube as a vent. An attempt at closure sometime ago led to recurrence of the sigmoid symptoms. The patient's age and general physical condition make a radical operation inadvisable.

In one case a portion of small intestine had to be resected on account of obstruction resulting from peritonitis secondary to sigmoiditis. The sigmoid inflammation subsided without resection. In six patients a resection of the sigmoid was done. In one of them a primary resection with end-to-end anastomosis was performed, while in the other five the Mikulicz technic was used. One of these patients has a permanent colostomy.



*Pathological Examination of Tissue*—The gross specimens removed in cases of sigmoiditis show a red, hard, often rather nodular tumor. The appearance is due to thickening of the wall, involvement of the appendices epiploica and diverticulæ, as well as adhesions of surrounding tissue. Frequently, there is a fibrin deposit and there may be an encapsulated abscess. The serosa is usually rough and granular. On opening the specimen it is surprising how little actual obstruction exists. The mucosa may be normal, or it may show redness and superficial erosions, but no real ulceration. It is at once evident that the lesion does not arise in the mucous membrane as in the carcinoma, but is confined to the wall and perisigmoid tissues. Although sometimes a good-sized diverticulum is found, perhaps filled with pus, it is not always possible to demonstrate openings into diverticulæ or even into a single diverticulum. This corresponds to some of the X-ray find-

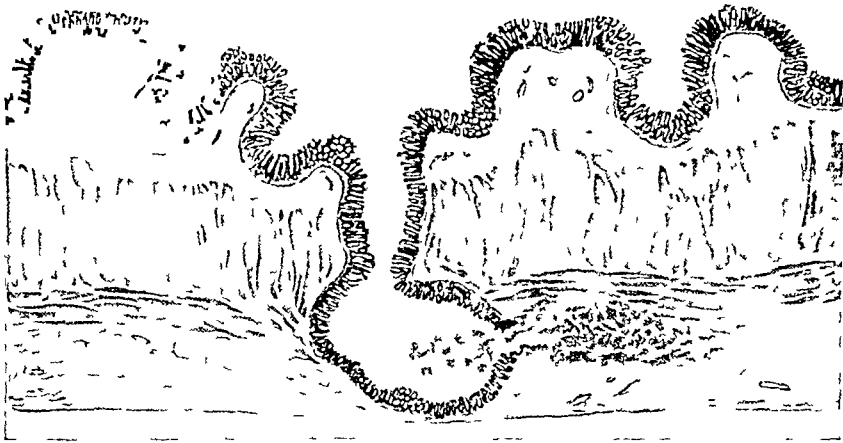


FIG 9—Semidiagrammatic presentation ( $\times 200$ ) (after Aschoff). The diverticulum has penetrated to the serosa. A perforation of the diverticulum has occurred.

ings in acute cases in which no definite diverticulæ are shown, but only a narrow lumen with an irregular filling defect. Pressure on such a specimen may cause oozing of retained feces or purulent material from several small ducts in the wall, which are not visible on the serous surface of the gut as diverticulæ. They seem to be buried in the thick oedematous wall of the sigmoid. It has seemed to us that during the early stage, while a diverticulum is pushing through the wall of the gut, and before it becomes visible on the serous surface, it may become infected and perforate. But instead of perforating externally beyond the serous surface to form a peridiverticulitis or peritonitis, it may perforate laterally into the wall of the sigmoid where the infection spreads between the layers. This probably accounts for some of the extensive tumefactions of the sigmoid which can be felt through the abdominal wall. In two of our specimens we were able to demonstrate these intra-mural abscesses. (Figs 8, 9, and 10.)

The microscopical examination of all resected specimens showed diverticu-

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litis or sigmoiditis, while in two there was an associated carcinoma, both being gelatinous carcinoma (Figs 5 and 6)

*Results*—Of the eleven patients who recovered without operation six have remained well for several years, while five have had trouble at times and are probably no better off than they were before they came under observation. Unfortunately there is no specific treatment aside from general hygienic measures. The symptoms in these patients have at no time been sufficiently severe to warrant resection. There is some advantage in having a positive diagnosis, however, for these patients can take care of themselves and guard against recurrences to some degree. Should an acute surgical complication develop, prompt and correct treatment may be instituted.

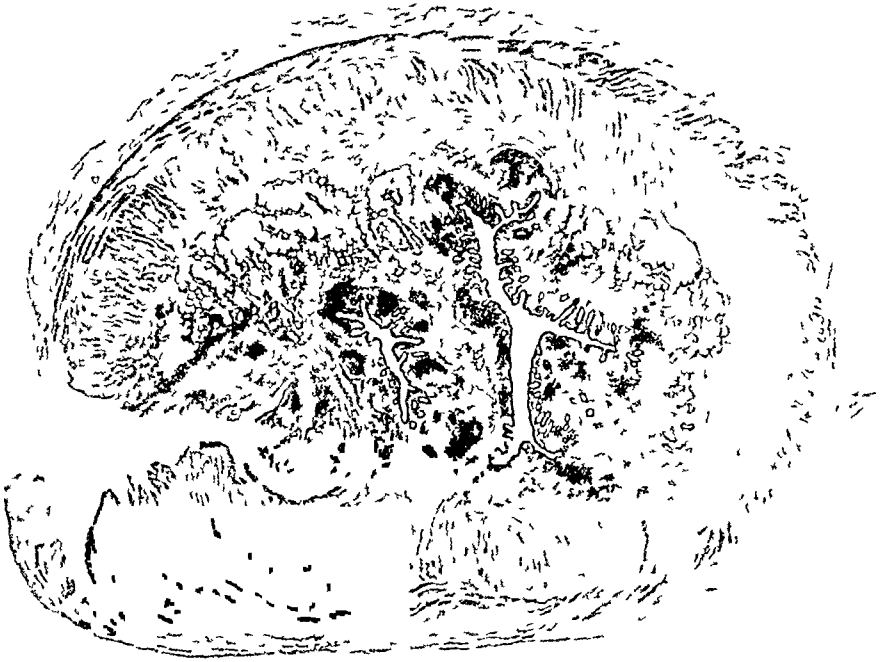


FIG 10—Cross section of appendix ( $\times 20$ ). The serous and muscular coats have been torn in sectioning. The larger central lumen is that of the appendix, the smaller one that of a diverticulum. An acute suppurative reaction has occurred about the diverticulum.

Of the operated cases five have died, four soon after operation and the fifth about a year later. Two were almost moribund when admitted and the operation was simply a desperate attempt to save them. All were very sick, as the following short abstracts will show.

CASE I—Mr M O, forty-six years, admitted four days after an acute onset of abdominal pain and vomiting. For years had attacks of indigestion, was troubled with gas, and at times had colicky pain in the left lower abdomen. Little blood in stool for many years. On admission chief complaint was pain and incessant vomiting. Looked very sick, eyes sunken, temperature  $100^{\circ}$ – $102^{\circ}$ , plus 90–120. A tender mass was palpable in the left lower abdomen with signs of peritonitis. White blood cells, 16,900, polymorphonuclears—86 per cent. Barium clysis, given carefully, showed deformity of sigmoid, 6 to 8 inches in length. Barium passed through slowly and filled upper descending colon and part of transverse. Operation was done within a few hours after admission. Suppurative peritonitis was found, pus removed by suction. A large inflamed

sigmoid was exposed, partly covered with fibrin. Loops of small gut were adherent on the mesial side. Upon separating them there was a gush of foul-smelling pus from a large abscess. In contact with this the wall of the sigmoid, over an area the size of a silver dollar, was gangrenous and flaccid. Pus had extended upward between the loops of intestines along the posterior abdominal wall and in the left lumbar gutter. To prevent further leakage and later be able to resect the affected gut, a first-stage Mikulicz operation was done. The arteries of the mesentery were found normal but several veins were thrombosed. Ample drainage was established. In spite of this the condition did not improve. Temperature rose to  $107^{\circ}$  and the patient died on the fourth day.

*Pathological Diagnosis*—Chronic sigmoiditis, acute suppurative perisigmoiditis. Sections stained for bacteria showed gram-positive bacilli and cocci.

CASE II—Mr. G. E., fifty-three years old, gave the following history. Abdominal distress lower left quadrant for three months, associated with soreness. No medical attention. Bowels normal. No urinary symptoms. Increased pain and fever for nine days. Became worse six days ago, had to go to bed and consulted his physician.

*Chief Symptoms*—Pain and discomfort lower abdomen, vomiting, and chills and fever. One severe chill four days ago following rectal irrigation. Diverticulitis had been suspected and an attempt had been made to improve his condition sufficiently to transfer him to the hospital for X-ray examination. Blood count had been low. He had apparently improved, and on the morning of admission he felt quite well, had normal temperature and was sitting out of bed. Early that afternoon he had a sudden agonizing pain in the left lower abdomen, he became covered with perspiration and developed a chill lasting half an hour. Temperature rose to  $104.5^{\circ}$ . After this, pain continued severe and the abdomen became enormously distended. The patient was seen by us about five hours after this acute onset. With the history of left-sided pain a diagnosis of peritonitis secondary to diverticulitis was made. Immediate operation done. Thin pus with colon odor was present under pressure. Loops of small intestines were acutely inflamed matted together with fibrinous exudate, and pus flowed from every direction. Chief focus of infection was in the left lower quadrant. The sigmoid was a hard, infiltrated tumor mass bathed in foul-smelling pus. No gross perforation found. Pus removed by suction. Extensive drainage instituted. The peritonitis did not clear up. Heart and kidney complications developed and the patient died on the eleventh day. The culture showed colon bacilli and short chain streptococci.

CASE III—Mrs. M. P., sixty-eight years old, had been under observation for a long time on account of nausea, vomiting, loss of weight and constipation associated with pain in the lower bowel. An X-ray diagnosis of multiple diverticulæ of the sigmoid with obstruction had been made. When she came under our care she had been kept alive entirely on intravenous glucose injections and hypodermoclyses. She had apparently a very marked reverse peristalsis with fecal vomiting. The first stage of a Mikulicz operation was done under Pernoxton anesthesia and a small opening immediately made in the gut to favor drainage. There was no improvement. The involved area was then resected, but vomiting continued. Transfusion and feeding into the colon did not improve the general condition. She died eight days after operation from general asthenia. The specimen presented numerous diverticulæ filled with hard concretions. At one place the lumen was completely obliterated by a semi-gelatinous translucent tissue which was later reported gelatinous carcinoma (Fig. 5).

CASE IV—Mr. N. D., seventy years old, was operated on by us in 1926 for a right subphrenic abscess and a liver abscess of amebic origin. He had some intestinal symptoms at the time, but they were insignificant compared with his chief complaint. He recovered and gained much weight. After a while he began to have attacks of pain over the left lower quadrant, associated with constipation and discharge of blood and mucus. Proctoscopy and X-ray examination showed a filling defect with irregular configuration (Fig. 7).

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Finally, in 1929, he was operated on by another surgeon. An inflammatory lesion of the sigmoid was found, and after separating several bands the abdomen was closed without drainage. A resection with anastomosis was considered to be the proper procedure at the time, but technical difficulties, the advanced age of the patient, and his poor general condition made that inadvisable. He continued to have attacks of pain in the left lower abdomen with constipation and blood and mucus in the stools. Six weeks before admission his condition became quite bad, he had spasms of pain, then again a steady soreness in the left lower quadrant. Heat had relieved him some. There had been no vomiting. When admitted he was very sick, he made a septic impression, his evening temperature rose to almost  $104^{\circ}$ , and the pulse was 110. Underlying the left rectus scar there was a firm, rounded, tender tumor mass extending upward as far as the umbilicus. Blood examination showed white blood cells, 28,400, polymorphonuclears, 84 per cent. Fluctuation developed in the mass, a small incision was made and much foul pus and gas evacuated. After a few days feces also began to discharge through the wound. In spite of the drainage the patient died from sepsis and general exhaustion. Culture of pus showed *Bacilli coli communior*.

CASE V—Mrs. A. S., fifty-eight years of age, was admitted for acute intestinal obstruction. It was known that she had diverticulosis of the sigmoid and colon, having been under treatment for that condition from time to time. It had been verified by X-ray a year before. During the last few weeks pain in the left lower quadrant had become more intense and was associated with spasm of the sphincter. A tender mass had gradually developed on the left side and rectal examination had shown a tender mass filling the cul de sac. Two days before, she began to have colicky pain over the entire abdomen, associated with distension, vomiting, and constipation. The condition rapidly became worse, necessitating admission to the hospital. She had a temperature of  $100.6^{\circ}$ , and her pulse was 110. The abdomen was enormously distended, and was conical in shape. It was tender all over but there was no rigidity. Loops of gut could be palpated, but no peristalsis was noted. Vaginal and rectal examinations were unsatisfactory, the pelvic organs seemed to be matted together. No detail could be made out. There was no tumor to be felt. Diagnosis of intestinal obstruction was made. The history indicated the sigmoid region as the site of the lesion most likely inflammatory in character. This did not quite explain the findings, however, especially the conical-shaped abdomen. Further observation advised. The patient was catheterized and a rectal irrigation given. No feces returned, but considerable gas. On re-examination stiffening of the gut was noticed, indicating obstruction of the small gut.

A barium clysma was then given. It showed an extensive lesion of the sigmoid, but a small amount went through into the descending colon almost to the splenic flexure, outlining several diverticulæ. Hugely distended coils of small intestines were also noted. This finding seemed to point to two lesions: 1. An acute obstruction of the small intestines. 2. An incomplete obstruction of the sigmoid.

An immediate operation was done, using a midline incision. Considerable free fluid found, clear, nonodorous. All cultures were negative. There were extensive adhesions. Colon and small intestines were enormously distended and red. The sigmoid for its entire length was contracted, hard, nodular, and its mesentery had been obliterated by the inflammatory process. A loop of small intestines was firmly adherent deep in the pelvis on the left side, and several other loops had formed light adhesions. The angulated loop was carefully and bluntly separated. It had apparently been completely shut off. There was an area of constriction about  $1\frac{1}{2}$  inches long. As soon as released intestinal contents passed through into the collapsed gut below. The pelvic organs were small and matted together. There was no pus found. On account of the enormous distension of the colon a cæcostomy was done through a separate incision on the right side. Cæcum opened at once and about 1000 cubic centimetres thin fecal material removed by suction. Median incision closed without drainage.

The patient reacted well. The cœcostomy began to function and gas and feces were also passed through the rectum. Temperature, however, continued, and after a while a tender mass developed in the left lower abdomen. Conservative treatment was continued, supplemented by X-ray and vaccine treatment until the impression was gained that a perisigmoid abscess had formed. An operation was done for this condition but no pus was found, just hard infiltrated inflammatory tissue. Later a perforation of the sigmoid developed spontaneously on the left side with fecal discharge. It became apparent that it would never be possible to resect the involved sigmoid on account of the extensive involvement and the numerous adhesions. A permanent colostomy was therefore done as close to the lesion as possible, and the cœcostomy closed. After a while the patient became ambulatory but she remained an invalid and died about a year after the first operation.

The remaining eight patients who were operated on are living. On account of the interest attaching to them a short report of each is given.

CASE I—Miss V. L., forty-eight years old, had for two years complained of severe attacks of cramps in the left lower quadrant, associated with tenesmus and at times diarrhoea. Examination showed tenderness over the sigmoid, but no mass. Rectal temperature varied from  $99^{\circ}$ – $102^{\circ}$ . Examination of the feces was negative for blood. Repeated X-ray examinations showed constant irregularity and narrowing of the lumen of the sigmoid with retention of barium. A diagnosis of sigmoiditis was made, and on account of suspicion of carcinoma an operation was advised and performed by another surgeon. An inflammatory condition was found and the abdomen was closed without drainage.

CASE II—Miss A. S., forty-eight years old, was first seen four weeks after the onset of an acute disease which was at first diagnosed as influenza, and after a few days as pelvic peritonitis of unknown origin. She had been confined to bed all this time and had run a temperature of  $103^{\circ}$ – $104^{\circ}$ . She had complained of vomiting and pain over the lower abdomen, associated with urinary difficulty and constipation. A daily rectal irrigation had brought some relief, but only a little fluid could be introduced at a time. She looked sick and very anæmic. The temperature was  $103^{\circ}$ , and the pulse 104. The general examination was negative. In the lower left abdomen a tender mass could be felt which apparently arose from the pelvis and extended upward to the level of the umbilicus. Vaginal examination showed the uterus and right adnexa normal, while on the left side a mass could be felt, situated high, and apparently plastered against the lateral pelvic wall. It was very tender. Rectal examination verified these findings. A diagnosis of sigmoiditis was made and an operation advised.

Through a median suprapubic incision an interesting picture presented itself. A large, red, nodular sigmoid tumor was adherent to the lateral pelvic wall. An infiltrative process extended from here into the anterior abdominal wall and the urinary bladder, to both of which the tumor was adherent. By careful blunt and sharp dissection the tumor was gradually separated from the bladder and then from the pelvic wall. There was no abscess present. After freeing it, the mass could be drawn upward for about 3 inches away from the bed where it had been adherent. The wall of the gut itself was thick and œdematous, and the appendices epiploica and the mesentery were extensively involved. A culture was made from the tumor bed and one of the inflamed appendices, as well as several enlarged lymph-nodes, were removed for culture and section. All these cultures and sections were subsequently reported negative. The bladder slipped back into position. The pelvic organs were found to be normal. The appendix was removed. A cigarette drain was inserted into the tumor bed and the normal sigmoid placed over it, while the inflamed sigmoid was left free at a higher level where it would most likely not form new adhesions. After a few days the temperature came down, but did not reach normal for several months. During all this time there was a moderate amount of drainage containing streptococci. At times the

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fever would rise to between  $103^{\circ}$  and  $104^{\circ}$  for a few days and then subside again. Several transfusions were given and two courses of deep X-ray therapy, both of which seemed to bring definite benefit. The sigmoid lesion which early in the disease showed a marked defect with spasm and retention (Fig 11) gradually improved until about the time of discharge it looked practically normal. The patient has remained entirely well since (Fig 12).

CASE III—Miss B. C., forty-nine years old, came under observation after she had been ill for about nine weeks. She had been discharged from another hospital after a stay of seven weeks with the diagnosis of peritonitis of unknown origin, possibly pelvic. At the onset she had had general abdominal pain and vomiting with a temperature of  $105^{\circ}$ . She had gradually improved and had been discharged two weeks before she came under our care. She promptly got a recurrence and suffered intensely. When admitted to our hospital the severe pain had subsided and vomiting had stopped. Her chief complaint was pain in the right lower abdomen, whereas formerly it had been more on the



FIG 11



FIG 12

FIG 11—Large filling defect due to acute sigmoiditis. Was operated on and tumor liberated.

FIG 12—Same case two months later after drainage and X-ray treatment. Complete restoration of lumen.

left side. She was quite constipated. There was tenderness over the entire abdomen, perhaps most marked over the region of the gall-bladder, associated with some rigidity. The pelvic organs seemed negative. There was general peritoneal irritation, but no indication of the primary seat of the infection. The temperature gradually came down. X-ray examinations were made, but did not lead to a positive diagnosis. No diverticulæ were observed. The probable diagnosis was inflammatory process right lower quadrant. Operation was performed because patient continued to complain of pain. A lower right rectus incision was made. There was some free fluid (cultured and later reported negative). There was evidence of an old general peritonitis in the form of dense adhesions. General exploration was done. No evidence of pancreatitis or perforated gastric or duodenal ulcer. Gall-bladder covered with adhesions, enlarged, thickened, and filled with stones. There was no evidence of perforation. The appendix was large, red, and hung into the pelvis where it was adherent. It was removed. The pelvic organs were matted together. No pyosalpinx, no evidence of tuberculosis. A

loop of lower ileum was adherent in the pelvis and so angulated as to cause incomplete obstruction. After separating it a perforation was found at the apex of the angulation. Whether this was entirely the result of manipulation could not be determined. It was considered that it might be an old perforation and the cause of the general peritonitis. (This was later disproved because no ulceration was found in the lumen.) The affected portion of gut, about 8 inches, was removed and an end-to-end anastomosis done. No other pathology found. Drainage was established and the abdomen closed.

The convalescence was uneventful. A sinus persisted for a long time and was later excised. She was well for about four years, when she developed severe cramp-like abdominal pain and vomiting. She was re-admitted five days after the onset. The abdomen was distended. A good-sized ventral hernia was present but was easily reducible and apparently not concerned in the symptoms. There was slight tenderness and rigidity over the entire lower abdomen, but on the left side there was marked tenderness and rigidity and an ill-defined tender mass. The temperature was  $102.2^{\circ}$ , pulse 108, white blood-cells, 17,500, polymorphonuclears, 85 per cent. A diagnosis of probable sigmoiditis was made. Conservative treatment was followed and in about ten days the temperature was normal. A barium clysis showed a long, narrow, channel in the sigmoid region which appeared to be due to spasm. No diverticula were visible. There was retention of barium.

An operation was performed, primarily to repair the ventral hernia, and secondarily to explore the abdomen. It was interesting to note that all signs of the old peritonitis had disappeared. There were no adhesions and the site of the end-to-end anastomosis could not be identified. A large, nodular, tumor was found in the sigmoid. It was red and apparently an acute sigmoiditis. No free fluid or pus present. Tumor not disturbed, but the hernia was repaired. The patient has remained well. It was considered that the original attack of peritonitis was secondary to sigmoiditis.

CASE IV—Mr. M. L., seventy-five years old, was seen July 15, 1929, on account of suspected intestinal obstruction. His chief complaint was constipation and abdominal distension. He had not had a real movement for ten days. He had cramp-like pain and hiccough. The temperature was  $99.6^{\circ}$ , pulse 68. He had not lost weight. X-rays had been made a few days before. They showed very much distended large and small intestines. A barium clysis outlined very marked narrowing and deformity of the sigmoid. The abdomen was enormously distended and tympanic, and one could see the outlines of the large loops of gut. No detail could be made out. Diagnosis of obstruction was made, probably due to carcinoma of the sigmoid.

A cæcostomy was done to give relief and allow more careful examination later. The gut was opened immediately and a large quantity of fluid, frothy feces evacuated by suction. Hiccough stopped at once and the size of the abdomen diminished. There was a sharp febrile reaction for a few days. During the next few days drainage through the tube diminished, and feces and gas began to be passed per rectum. Repeated X-ray examinations have been made since. There is no evidence of carcinoma. Barium clysis shows a peculiar irregular worm-eaten area at the junction of the descending colon and sigmoid, associated with a severe spastic condition of the colon which has been diagnosed as an inflammatory lesion. The patient has remained well with the cæcostomy tube in place. There is only a very little discharge. The bowels move well. An attempt was made some time ago to close the cæcostomy, but it resulted in a recurrence of the sigmoid symptoms and made reopening necessary. The age of the patient and his general condition make a resection inadvisable.

CASE V—Mr. C. R. first came under our care in 1923, when he was forty-four years old. He complained of attacks of abdominal pain which he had been having for several years. The pain was at times quite severe, and localized in the left lower abdomen. There was no vomiting. There was always trouble with gas which seemed to stick on the left side. The bowels moved fairly well, but the stool was thin and ribbon-like of late. There had not been any blood. No loss of weight. Examination showed

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tenderness over the lower left abdomen, no rigidity, no mass. A barium clysma was done and showed typical diverticulosis of the sigmoid and colon (Fig 2)

Instructions as to proper hygiene were given and the patient was not seen again until three years later when he was admitted to the hospital with an acute abdomen. Symptoms had started two days before with severe sharp pain just above the bladder. There was no vomiting. Pain would come and go and at times had been severe. The abdomen was distended, and there was tenderness and rigidity over both lower quadrants. Rectal examination was negative. Temperature was 100.8°, pulse 96, white blood cells, 16,400, polymorphonuclears, 74 per cent. A diagnosis of peritonitis was made. In view of the known presence of diverticulosis, perforation of a diverticulum was considered as a likely cause. Operation was performed through a median incision. Loops of inflamed small intestines were found, but no free fluid. The appendix was red and was removed. The sigmoid was then exposed. In the upper part it looked fairly normal except for numerous diverticulæ filled with hard concretions. On following it downward free turbid fluid was encountered, which was cultured. The fluid surrounded a hard mass in the lower part of the sigmoid, about the size of a tangerine. After exposure it was found to be acutely red and the fat overlying it was œdematous. It was partly covered with fibrin. Adherent to it was a loop of small intestines, likewise covered with fibrin. The small gut was separated, but it was deemed wise not to disturb the mass for fear of opening a sealed perforation. A cigarette drain was placed on the outer side of the mass, and the omentum over the loops of small gut to separate them from the inflammatory mass. Abdomen closed around the drain. The culture showed colon bacilli and hæmolytic streptococci.

The convalescence was uneventful, but attacks of pain continued and increased in severity. At times they would last for hours. There was no vomiting, and no blood was noticed in the stool.

It was decided to do a resection. The operation was done in one stage, with an end-to-end anastomosis. The convalescence was stormy and was complicated by eventration and pneumonia. The final result has been very satisfactory.

CASE VI—Mrs M. E., sixty years old, was admitted a few months ago with the diagnosis of acute intestinal obstruction. She took sick about twenty-four hours before with severe cramp-like abdominal pain. She vomited only once. Had not passed gas or feces. An enema had resulted in quite a hæmorrhage without any stool.

The abdomen was irregularly distended, partly due to a very large ventral hernia in an epigastric scar, through the covering of which active peristalsis was visible. There was no tenderness over the hernia and one got the impression that it was not concerned in the symptoms. There was a well-healed median scar below, and the entire lower abdomen was tender and rigid. There was suspicion of a mass. Vaginal and rectal examinations were negative. The patient had a temperature of 101.4°, pulse 96, white blood cells, 13,500, polymorphonuclears, 68 per cent.

An operation was done immediately without a positive diagnosis as to the cause of the symptoms or the position of the lesion. There was free fluid present which was cultured (Later reported negative). A hard, nodular, tumor could be felt in the pelvis. It was quite adherent. In order to gain access to it several loops of small intestines which were adherent to each other and to the abdominal wall had first to be liberated. Some of these adhesions were old, while others were of more recent origin. The latter particularly involved the tumor and produced angulation and incomplete obstruction of the small gut. Further exploration then showed the tumor to be adherent to the bladder and surrounding structures. After liberating it and drawing it out of the abdomen it was found to be a tumor of the sigmoid. It was somewhat red and partly covered with fibrin. It was very hard and apparently completely obstructed the lumen. Whether it was a sigmoiditis or carcinoma could not be stated. Resection was decided on and the first stage of a Mikulicz operation done.

After resection of the mass it was found to be an acute sigmoiditis with a per-



forating diverticulum which had formed an abscess in contact with the walls. Surrounding the opening of the diverticulum was a flat carcinoma, later reported gelatinous carcinoma (Fig 6)

The patient is still under care but is doing well

CASE VII—Mrs E V came under our care in 1916 when she was sixty-one years of age. Five years previously she had had a resection of the sigmoid done by one of my colleagues for what was supposed to be carcinoma but later reported sigmoiditis. An anastomosis had been done but on account of leakage, infection developed, requiring prolonged treatment and eventually a permanent colostomy. The colostomy functioned well. A sinus was present in one of the scars of the abdomen and led down to the rectal stump. The anus had contracted so that examination was not possible. Fluid injected into it escaped through the abdominal sinus. The patient's chief complaint was cramp-like abdominal pain associated with discharge of pus from the sinus. She was operated on and the sinus tract was completely excised down to the stump of the rectum which had been allowed to stay in. The gut was closed and the wound eventually healed. The anus was stretched to allow drainage downward. After this the patient was well until 1929 when she again began to have attacks of abdominal pain. At first they were attributed to the gall-bladder which was known to be filled with stones, but later the symptoms were more definitely intestinal in character. Gradually the pain became worse, and the patient felt as if gas stuck in the intestines and could not be expelled. Then tenderness developed over the lower abdomen to the inner side of the colostomy and after a while a mass became palpable. Carcinoma was suspected but exploration with a finger in the colostomy was negative, and an X-ray examination showed no deformity. The mass seemed to be situated between the lumen of the gut and the abdominal wall. Finally redness of the skin appeared and the tissues became very tender. Diagnosis of diverticulitis was made, probably with perforation, and operation advised. The gut was exposed for a considerable distance above the colostomy. The wall was hard and infiltrated but there was no free pus present, and no individual diverticulum was recognized. Drainage was established and a good recovery resulted. The patient has remained well since.

CASE VIII—Mr J G, sixty years of age, was admitted to the Lenox Hill Hospital April 28, 1930, complaining of severe pain in the left lower abdomen and constipation. In the left lower quadrant, opposite the anterior superior spine a small, hard, elongated tumor mass was palpable, which was tender to touch. Rectal examination gave the feeling of an indefinite, somewhat smooth, evasive mass, which did not impress as an ulcerating lesion. With a history of recurrent attacks of pain for almost a year, which was so severe that he was unable to stand, with constipation for eight months, and the presence of a mass in the sigmoid region, a diagnosis of a surgical condition was made. He had no temperature but there was leucocytosis of 16,000 white blood cells, with 85 per cent polymorphonuclears. We inclined to the diagnosis of sigmoiditis. X-ray examination showed multiple diverticulæ in the descending colon and the sigmoid. An irregular shadow suggesting a cavity connecting with the sigmoid was noted and was interpreted as a rupture of a diverticulum (Fig 4)

At operation there was no free fluid. An inflamed sigmoid was found bound down in the iliac fossa. It was carefully separated and a culture made from the bed (later reported negative). After mobilization it was found that about 3 to 4 inches were involved in an acute inflammatory process which had led to marked thickening of the wall. In one place it looked as if a perforation had taken place but it had become plastered over with exudate. Resection was decided on and the first stage of a Mikulicz operation done. The affected portion of gut was removed ten days later. On opening it the lumen was found to be very small, but the mucosa looked normal. The perisigmoid tissue and the wall itself were very thick and infiltrated. Several incisions were made into this tissue and cultures taken. Pressure on the wall caused exudation

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of thin pus, especially at one point representing the opening of a diverticulum which had perforated. A culture was made of this pus.

The patient made a good recovery and is well today. The following pathological report of the specimen was received:

*Microscopical Examination*—"Sections obtained from various parts of the sigmoid show a congested mucous membrane which is largely denuded of epithelial covering and in several places shows small superficial erosions. The glands are usually enlarged and rich in goblet cells. The stroma in many places is more or less sclerotic and slightly infiltrated with inflammatory cells. Throughout the mucous membrane are small hæmorrhagic extravasations. The remainder of the wall shows considerable fibrosis. Just beneath the mucous membrane and involving the submucous muscular and outer coats is an irregular abscess lined with thick vascular granulation tissue which is densely infiltrated with inflammatory cells of all varieties and contains a number of foreign body giant cells. A very small part of this cavity is bordered by intestinal mucous membrane. In none of the sections examined is there observed a communication between the cavity and the lumen of the gut. The fat tissue attached to the outer surface of the specimen is involved in the chronic suppurative inflammation. Sections stained by the gram method fail to demonstrate the presence of microorganisms. There are observed, however, clumps of microscopic, round, blue staining bodies which may be gram-positive cocci."

The bacteriological findings were as follows: Cultures from pus of diverticulum—*Bacillus enteritidis*. Cultures from incisions in wall of sigmoid—*Staphylococcus albus* and diphtheroid *Bacillus*. There were no anaerobic organisms present.

*Comment*—A group study of acute sigmoiditis and diverticulitis calls attention to the seriousness of this condition. It reveals that diverticulosis, as such, is not an innocuous lesion. Once recognized in a patient the physician or surgeon assumes a serious responsibility if he allows the patient to depart without warning him of possible danger and instructing him in the known means at our command to avoid complications. Many of the details of the long-drawn-out treatment in several of the cases in this series have been omitted, but it may safely be said that it is difficult to imagine a group of patients that tax a surgeon's judgment, ability, and patience, to a greater degree than these complicated cases of diverticulitis.

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# TREATMENT OF MEGALOCOLON BY SYMPATHECTOMY

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A STUDY of the clinical cases of megalocolon shows the fact that this condition is not because of atonia or lack of power and development of the musculature of the colon. Cameron<sup>1</sup> among others, has described the anatomic condition of the wall of the large gut, the increase in hypertrophy of the longitudinal and to a greater extent the circular muscle fibres. It is observed also that the dilatation of the colon is always greater on the left side. In some cases, indeed it is present only in the descending limb of the large intestine. In those cases where local excisions have been done of an enlarged loop of bowel, the commonest sequence is to have an enlargement form in the bowel replacing the loop. In one case I reported<sup>2</sup> the patient had had three operations, at each one of which loops of dilated large intestine were removed. This experience has been the not uncommon one following operations at which part or all of the large intestine has been removed for the cure of megalocolon.<sup>3</sup> One is, therefore, justified in concluding that operative procedures of this type do not cure the condition, and in addition it is obvious that the factor producing the dilatation is left still in existence. Its causative factor, therefore, cannot be something inherent in the wall of the dilated bowel. It would appear from this that the condition is really one of obstruction, not complete and constant but incomplete and intermittent. Clinically this has been observed.

Brennemann<sup>4</sup> and David<sup>5</sup> describe the condition associated with congenital strictures of the rectum.

Fullerton<sup>6</sup> believes that the pelvi-rectal sphincter is the factor in producing obstruction and quotes Hurst and the theory Hurst advanced of achalasia, that is, an absence of the normal relaxation of sphincters, in this case the pelvi-rectal or anal sphincter. Sphincter spasms are known elsewhere as in cardiospasm and pylorospasm, and Fraser<sup>7</sup> describes the condition as due to a neuromuscular error resulting in "an uncontrolled function, a delay in acquisition of the power of inhibition combined, it may be, with achalasia and insufficient relaxation of the associated sphincters."

A case herein reported shows the progressive enlargement of the colon in the time he was one and one-half to two and one-half years of age. During this time the capacity of the colon was much increased, as is shown in Fig. 1.

Hirschsprung's disease is described as a congenital dilatation of the colon, but if such a condition exists it must be very rare, as most of the cases that are followed closely are found to be of the type that are obstructive in origin. It is true that the majority of the cases of megalocolon that are

found in the young date then symptoms from birth or very soon after birth but no one has shown or proved that infants have large hypertrophied colons at or soon after birth. It would probably be an improvement in nomenclature if the term "congenital idiopathic dilatation of the colon" were dropped. The very anatomic fact of hypertrophy must surely denote an obstructive lesion lower down that makes necessary the hypertrophy in an endeavor to overcome it.

The surgical procedures that have been devised in the past for the correction of this condition by a direct attack upon the enlarged colon have given a high mortality, and those cases that have survived the operation have for the most part been failures in relieving the condition. Medicinal means have provided nothing approaching benefit. Means designed at dealing

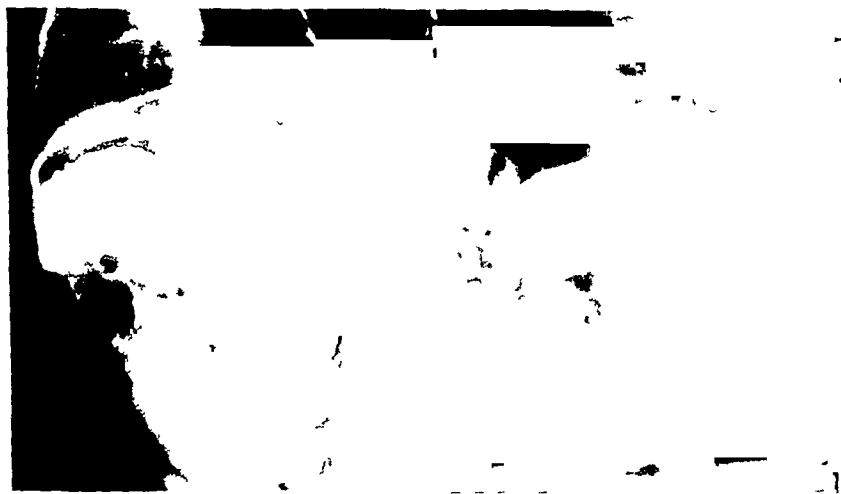


FIG 1—C T X ray of barium enema August 1929, aged ten months  
October, 1930, aged twenty two months

with the anal sphincter by stretching have been reported by Fullerton and others. There are reports of successful treatment by division of the sphincter of O'Bierne.

Since the application of original lumbar ramisection of Royle to this disease there has been an outstanding number of cases reported as cured. Wade<sup>8</sup> has reported recently fourteen cases. Judd and Adson<sup>9</sup>, Rankin and Learmouth<sup>10</sup> and others have reported a successful series.

Royle's<sup>11</sup> original contention was that the rami running mesially to join the hypogastric carried the fibres that maintained the spasm in the sphincters. He advocated the division of these mesially directed rami. He has done this type of operation in many cases since for the relief of constipation in cases other than megalocolon, and has reported cures.

Rankin and Learmouth presented to this Association last year in Philadelphia a paper wherein they described the division of the presacral nerve with the division of the rami from the lumbar ganglia. This is a transperitoneal operation. This operation is extremely interesting from an anatomic standpoint as well as from a practical one.

The procedure that we have followed has been to attack the lumbar sympathetics from the lumbar approach, and we have recently removed the whole trunk from the second down to the level of the fourth. This has produced in patients, in addition to the changes in lower bowel function, two grateful changes, *vis*, warm feet and dry feet, and no deleterious effects have yet been manifest from this proceeding. The operation of the approach through the flank, as recommended by Royle, is readily done and is undoubtedly rendered more easy by the use of spinal anæsthesia. After the flank incision the peritoneum is pushed forward and the sympathetic cord is readily felt lying on the anterior aspect of the lumbar bodies. In one case only of megalocolon have we done a bilateral operation, but in lumbar sympathectomies for vascular diseases of the extremities many cases of



FIG 2—M F K, 1931. Rays of barium enema. September 1927—March, 1931

bilateral operation have been done at the one visit to the operating room. The operation is, strangely, devoid of shock.

I have recorded the details of three cases of megalocolon treated by ramisection and ganglionectomy.<sup>2</sup> These three cases have continued well. One case operated upon in 1927 is having a normal bowel-movement history (Fig 2) (M F K, February, 1931). Another case, operated upon in 1929, had a relapse from the normal, but she was a child who came from a home that was altogether disorganized, the father in jail and the mother irresponsible. After a "clean-out" she is, however, having again normal movements. The third case, of a woman of thirty, who had, previous to double lumbar ganglectomy, had an appendectomy and three local excisions, reports after the experience of sixteen months no difficulty with movements. The volumetric change in the enema she could tolerate changed from 120 ounces to fill the sigmoid and ascending colon before operation, to 80 ounces to fill the entire colon two months after operation. This case showed a marked improvement in the haustra of the cæcum, and the right side was operated upon.

Three additional cases are here reported in detail.

## SYMPATHECTOMY FOR MEGALOCOLON

CASE I—C T, aged twenty-two months, October 29, 1930 Patient in hospital six months ago, complaining of constipation, since when he has had consistent medical treatment but there has been no improvement in his constipation nor general condition Abdomen has been getting progressively larger Patient has been vomiting more frequently than previously, two to three times a week After eating vomits practically everything taken Has failed to gain and is quite weak and suffers from lassitude The baby is a well-developed and well-nourished white male child, does not appear acutely ill

*Digestive System*—Buccal mucous membrane clear, tonsils present, throat not inflamed, pharynx is quite normal, abdomen is a large, distended, soft abdomen which is not rigid in any area, no tenderness, no masses can be felt, liver, kidneys and spleen not palpable He is quite cooperative at examination, appears quite intelligent and does not cry or become the slightest bit irritable at examination *Other Systems*—Normal *Provisional Diagnosis*—Hirschsprung's disease



FIG 3—C T X rays of barium enema one month after operation

*X-ray Report*—October 3, 1930 A barium enema was given today and the colon was shown to be markedly dilated throughout its whole length Its dilatation was much greater than that shown on examination on November 20, 1929, and is most marked in the sigmoid loop, which is both long and very capacious The case appears to be one of Hirschsprung's disease

*Operation*—October 29, 1930 An incision was made in the left flank, and, the peritoneum being pushed forward, the sympathetic trunk was exposed as it lay on the vertebral bodies The white ramus from the second lumbar ganglion was identified and divided The entire cord below this was removed

Following the operation his recovery was uneventful He was given an enema daily for the ten-day period he was in hospital and this was sufficient to give him a daily movement, and when he was last seen on May 31, 1931, he was having six to eight spontaneous movements a week (Fig 3)

CASE II—B F, aged two and one-half years, July 25, 1929 Has been constipated since six months Laxatives had no effect Enema daily, followed by a movement

half to one hour later Cries as if in pain, pulls hands and feet up Magnesia caused small watery movement Since the beginning, July, 1927, the fecal discharges have always been well formed Hard at first, now slightly softer This has persisted throughout *Mucus* Recently, last two months, comes before movement Greenish tint, small amount *Color*—Changeable, occasionally very dark green, almost black Sometimes clay color, exceptional *Odor*—Very foul-smelling always Has undigested food in stool sometimes Mother claims that child masticates food thoroughly Lasted first few weeks of constipation only Child otherwise has been very healthy *Sleeps*—Well for last eight months, at first restless and irritable *Appetite*—Very poor *Bowels*—Constipated *Pains*—Over abdomen, irregular Cries a lot with them Occur with a movement Also very irritable

The patient is a well-developed, well-nourished boy, not actually ill Tongue coated Buccal mucous membrane is clear Teeth in fair condition Tonsils are small and cryptic Pharynx is not congested Abdomen is full, rounded and soft Colon is palpable the whole distance from the right lower quadrant down to the sigmoid It contains a large amount of fecal matter, particularly the sigmoid, which is palpable in a large moveable mass in the pelvis The colon does not appear to be dilated and

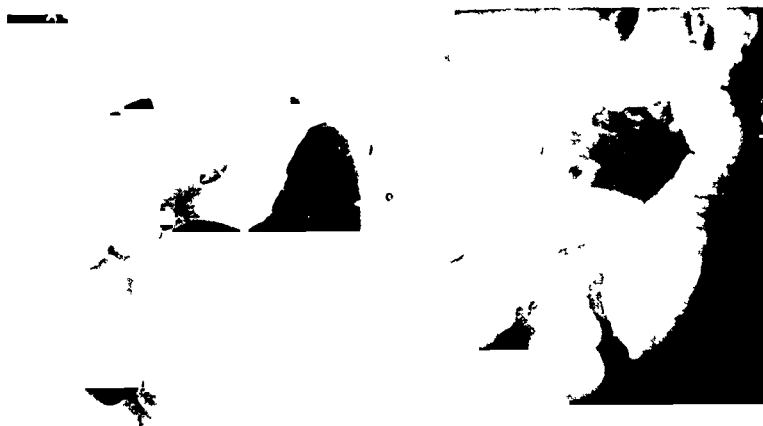


FIG 4—B F Two on one slide July 10, 1930 September 15 1930

is about normal in size Transverse is above the umbilicus and not apparently displaced It can be observed to move with respiration Liver, kidneys and spleen are not palpable No other masses No tenderness No meningeal signs No apparent motor or sensory defects Intelligence apparently normal *Diagnosis*—Hirschsprung's disease

After being in hospital two weeks he was sent home to have medical treatment, July 6, 1930 Again admitted to hospital Has not improved since leaving the hospital

*Special Examination*—Abdomen Abdomen is distended in appearance, but moves freely on respiration The note on percussion in the upper part is resonant, the lower part shows dullness There are masses felt in the lower portion of the abdomen These masses can be indented and are putty-like in consistency By rectal examination large masses could be felt in the lower bowel which were fairly firm in consistency but of putty-like consistency

*Operation*—July 16, 1930 A left-sided lumbar ganglionectomy through a flank incision

Following this the child had, while in hospital, enemas, but within a month had daily spontaneous movements The colon was materially changed, as evidenced by X-ray of barium enema Haustra were well marked and girth smaller Moreover, the giving of enema caused pain, whereas it was formerly born without discomfort and

## SYMPATHECTOMY FOR MEGALOCOLON

the colon had tolerated large quantities (Fig 4) Eleven months have passed since his operation and he remains well

CASE III—L S, male child, aged three years, June 10, 1930 Since birth child has had constipation and inability to move bowels Goes about a week without any bowel movement and the abdomen becomes greatly distended Complains then of pain and there is a watery discharge from bowels When bowels move large amounts of faeces are passed and distention disappears, also the pain No vomiting Has had "bowels stretched" at clinic Abdomen greatly distended Large hard swelling in region of caecum on right Rectal examination shows lower bowel densely packed with faeces

*Special Examination*—Abdomen is considerably distended, much larger than normal, distention is not entirely tympanitic, just partly so The abdomen moves fairly freely on respiration On palpation there are no areas of rigidity or of marked tenderness There is considerable swelling in the region of the caecum and the whole of the abdomen is large in size and fairly firm to pressure The swelling in the region of the caecum and in the left lower quadrant of the abdomen has a putty-like consistency and can be indented, on deep pressure Rectal examination shows the lower bowel markedly distended with faeces There is no marked tenderness on rectal examination



FIG 5—L S Two on one slide July, 1930 June, 1931

*Operation*—June 17, 1930 Under general anaesthesia of ether, vertical incision was made from the margin of the twelfth rib in the left side downwards and then curving forward along the crest of the ilium Subcutaneous tissues and part of the latissimus dorsi were incised Fingers were inserted to separate the peritoneum from fascia covering psoas muscle The peritoneum and intestines were then retracted forward and by means of palpation the sympathetic trunk was located and dissected out and a section removed including the second, third, and fourth lumbar ganglia Wound was then closed in layers with chromic catgut and horsehair Condition remained good throughout

Prior to operation this boy had in one morning fifteen enemas These were just sufficient to clear the colon Following his operation for a period of two weeks he was given daily enemas He was put on liquid paraffin and began to have one or more movements every day, a condition that is still present, just one year after operation X-rays of barium enema July, 1930, to June, 1931, show a remarkable difference (Fig 5)

The experience of these cases leads one to believe that the constipation associated with megalocolon can be cured by a left-sided lumbar sympathectomy In all cases here reported the patient either has spontaneous movements or has been rendered so that the slightest exhibition of medication



is sufficient to produce a resumption of normal habit. These cases, if not carefully supervised by those in charge of them, may develop the bad habit of neglecting to have regular defecation. Yet these are readily returned to a daily habit again. The administration of a barium enema at periods following operation gives ample evidence to the administrator of the reduced size of the colon and the spasm that is easily induced in the colonic wall. Colons that would, prior to operation, tolerate large quantities of enema, some time after operation suffer pain and a desire to expel when only a small quantity is introduced. The diminution in the size of the colon following operation takes some months to become marked. The presence of haustrations is likewise more marked as time elapses. Bowel function may show no marked improvement for some weeks. It is probably advisable to have daily enemas given following operation for the period the patient is in bed. After this period the patient may well be left to have spontaneous movements.

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# TOTAL COLECTOMY, ITS INDICATION AND TECHNIC

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THE frequency of occurrence of single or multiple polyps of the large bowel and rectum is in direct proportion to the care and assiduity with which one seeks them. They are almost always demonstrable in resected specimens from operations, in the mortuary or by proctoscopic examination. Their size and number are so variable that one may frequently experience difficulty in satisfactorily demonstrating tumor, and yet, in most instances, one readily makes out single or multiple polyps, varying in size from small protuberances of the mucous membrane, which histologically are of true polyp formation, to the diffuse lesion commonly recognized as the "polyadenomas en nappe" of Menetrier or as the polypoidosis of Broders.

My interest in polyps of the colon has been markedly stimulated recently by the study, with FitzGibbon, of thirteen cases in which we were able to demonstrate, to our own satisfaction at least, that there was no break in the sequence of steps from hyperplasia of the polyp type of growth to malignant change. This work so closely parallels the work of Wechsleman, Schmieden, Hauser and others, that the intriguing theory of the universal development of carcinoma of the colon from polyps forces itself on one's attention. Although this hypothesis is undoubtedly vulnerable, its apparent truth in a high percentage of cases demonstrates that one may not disregard the use of extremely formidable procedures in combatting conditions which definitely are shown to become malignant.

In the files of the Mayo Clinic are records of sixteen cases of total or subtotal removal of the colon. I have divided these arbitrarily into two groups, depending on the amount of bowel removed at operation, since the indications have been assumed to be similar in each instance. As subtotal colectomy I designate removal of the colon down to, or almost to, the juncture of the sigmoid with the rectum, whereas the term total colectomy is used to indicate complete excision of the colon, sigmoid and rectum. There is disagreement in the literature as to whether removal of merely the large bowel, leaving the rectum, should not be called total colectomy, but it is the latter group, in which the entire colon and rectum have been extirpated, that I wish to call to your attention in reporting six cases in which the operation has been done within the last three years for definite organic lesions. Such a formidable procedure as this, obviously, should not be undertaken lightly, and distinct indications should govern its selection.

There are two general types of conditions which call for total colectomy. A definite primary lesion, and a secondary lesion. The term "polyposis" has

been used to designate the primary type of lesion, but I agree with Erdmann that "diffuse adenomatosis" is a better and more satisfactory term, and with Broders that "polypoidosis" is a much more descriptive pathologic term. Polyposis, for instance, may mean only two polyps, either sessile or pedunculated, or any number of polyps of the colon. Polypoidosis, on the other hand, indicates that the entire lumen of the large bowel, from the anus to the cæcum, is studded with projections which raise the surface of the intraluminary portion of the bowel, and between which there are small strips of normal mucous membrane giving it the appearance of many convolutions, as in the brain. The secondary lesion is advanced, complicated, chronic ulcerative colitis which, in some of its ramifications, acts as focal infection or produces pseudopolyposis, which is, in itself, a potentially malignant condition, or at least, in my experience, malignancy has occurred simultaneously with it.

Polyps of the large bowel generally have been treated as a single genus of tumor and have been described anatomically as pedunculated or sessile growths, varying in size, shape and consistence, with an underlying papillary or adenomatous structure. Many authors have classified these growths according to some etiologic factor, such as dysentery, ulcerative colitis, hyperplastic tuberculosis, or non-specific affections of the large bowel. Again, the clinical manifestations, particularly as regards diffuse adenomatous types of polyps, have caused them to be classified as of the adult or acquired type, and of the congenital or adolescent type. Unquestionably, the presence of polyps, occasionally single but frequently multiple, in the colon and rectum, is of grave significance in relation to the ultimate development of carcinoma of this organ. Furthermore, polyps occur in the large bowel and rectum four times more often than in other portions of the gastro-intestinal tract. Their presence in the rectum, rendering them particularly accessible to study, and in resected colons, has caused me to undertake evaluation of their relationship to carcinoma, on the basis of histologic study, without regard to the etiologic factor involved.

Anatomically and pathologically, there are two general types of polyps in the colon, one of which is a true neoplasm, the other the result of an inflammatory reaction. One form of the true neoplastic or congenital type of this condition has been designated by Erdman as "diffuse adenomatosis" and I am inclined to think this term, or "polypoidosis," or "polyadenomes en nappe," as Menetrier designated the condition years ago, would be preferable. The other form in the colon, of the congenital type, may be present either as one or two discrete tumors, or as discrete tumors which involve the entire mucosal surface of the bowel from the anal canal to the ileocecal coil, and is, in reality, more of a true neoplastic condition as compared to polyadenomes en nappe or polypoidosis. Both usually occur in families and the former is known to undergo malignant change in from 40 to 50 per cent of the cases. In this form, small, raised elevations of the mucous membrane a few millimetres in diameter may occur, or the elevations may be scattered

throughout the entire bowel and may be represented by all sizes up to and including large, pedunculated tumors, which are several centimetres in diameter. Occasionally tumors sufficiently large to cause intussusception and obstruction have been found. Under the term polyadenomes en nappe Menetrier recognized in the stomach glandular hypertrophy that caused great thickening of the mucous membrane, but differing from polyadenomes polypeux, he thought, in that the glands were increased in height but preserved most regularly their vertical direction. Their length was increased five to seven times, whereas their breadth varied from slight increase to actual diminution. On the other hand, he considered the pathologic picture of polyadenomes polypeux as similar to polyadenomes en nappe. He thought that the glands were less markedly changed in their various diameters than in polyadenomes en nappe, and that the inflammatory reaction, as represented by the round-cell infiltration and increase in connective tissue, was a much more prominent feature. He believed that the two types, therefore, might be considered as similar, in that they represent mucosal hypertrophy. It is reasonable to believe that whether single tumors or multiple tumors in the large bowel are of congenital origin or are the result of an inflammatory lesion in the bowel, when they reach a point in their growth at which they may be called polyps, the metamorphosis into carcinoma is identical.

*Polypoidosis the first indication for total colectomy*—FitzGibbon and I traced thirteen cases of multiple polyps of the colon through the sequence of events from a benign to a malignant condition. Forty years ago, Hauser, excluding all growths having a possible inflammatory background, proposed that polyps be grouped according to the amount of degenerated epithelium in them. Wechselman, in 1909, devised a three-phase scheme of classification, limiting his critical analysis to the epithelial elements of the tumors, whereas Schmieden and Westhaus, in 1927, by introducing the relationship of selected attributes in the connective-tissue framework, formation of pedicles, and macroscopic appearance, rendered the Wechselman criteria more useful. Reviewing the histopathologic characteristics of the polyps in our cases, we were able to show conclusively that they were not all of a piece, and that those in this series definitely proceeded from benignancy to malignancy. The polyps are divided into three distinct groups, varying grossly as well as microscopically.

In Group 1 the epithelial elements are practically normal, the tumors are rough nodules on the mucous surface of the bowel, varying from tiny clubs to masses 2 centimetres on gross section. It is conceivable that this type of polyp may become malignant, but there is small evidence that it has any more tendency to such change than normal mucous membrane.

The polyps of Group 2 are easily distinguished from the foregoing, and the structural changes in both the epithelium and connective-tissue elements are abrupt and striking. The epithelium fails to differentiate into normal intestinal mucosa. The cells are elongated, and, by their increased bulk, compressed laterally. They may be arranged in single rows, but frequently

are pushed into multi-layered buds which project into the lumens of the tubules, but more often into the connective-tissue matrix. The nuclei are elongated, take stains deeply, and give to the proliferating tissue a darker color. As this epithelial proliferation progresses, there is a complimentary response in the connective tissue of the muscular and submucous coats, which produces a stalk. The pedicles are large or small, according to the rapidity of the proliferation. I feel that the tempo of the development of the carcinoma in polyps is an extremely important factor in their metamorphosis.

In Group 3, the epithelium is almost completely undifferentiated. It is an accentuated form of that seen in Group 2. The development of the epithelial proliferation, which outpaces that of the connective tissue, results in a polyp which is of complex histologic structure. Grossly, the polyps of Group 2 may attain large size and age, whereas those of Group 3 rarely do, becoming early, I believe, deep, infiltrating carcinomas.

This congenital type of polypoidosis, recognized, as it is, as a precursor of malignant growth in a high percentage of cases, is not an exceedingly rare entity, Bagen gives its ratio to the acquired type as approximately 1 to 4. The congenital or adolescent type manifests itself in young persons by profuse rectal hæmorrhage and diarrhoea, associated with concomitant anæmia, and occasionally with acute intestinal obstruction. This disease was first described by Virchow, in 1863, as "colitis polyposa," and Cripps, reviewing three cases which occurred in one family, shed more light on the subject in 1882, when he described accurately the conditions which is designated as polypoidosis. Cripps' first patient, a man aged twenty years, had had symptoms for ten years, and polyps had been removed by way of the rectum with only temporary relief. This patient succumbed suddenly, and post-mortem examination disclosed that death was due to adeno-carcinomatous stricture of the sigmoid, which occurred in the presence of diffuse, pedunculated polyps. Subsequently, Cripps reported two other cases, those of a brother and a sister of the first patient, aged seventeen and sixteen years, respectively.

One patient on whom I performed total colectomy had a sister who died at the age of twenty-eight years with multiple polyps of the bowel, and a brother is now being treated at the clinic for multiple polyps of the bowel, at this time the brother is resting between stages of operation for removal of the entire colon.

Erdmann's two patients were youths aged fourteen and sixteen years. Neimack, I believe, reported the case of the youngest patient on record, that of a girl aged twelve years, who had had symptoms for three years.

The diagnosis of congenital polypoidosis is usually made by digital or proctoscopic examination, because the polyps invade the rectum as well as the entire colon, and are both palpable and visible, even on cursory examination. Röntgenograms, especially those made by the combined method of Fischer, in which an opaque enema is followed by rectal injection of air, are especially accurate in interpretation of the presence and distribution of polyps. Usually the entire bowel is studded with small tumors, interspersed among

## TOTAL COLECTOMY

which are tumors sometimes as large as 3 centimetres in diameter, attached to a slender pedicle. Depending on the number of tumors, normal mucosa will appear in the lumen of the bowel, but in one of the cases the tumors were so diffusely scattered that scarcely any normal mucous membrane was visible. Usually they had a narrow pedicle with a clubbed head, and the larger tumors occasionally had extruded through the rectum, or had been broken off higher in the intestinal canal.

The two especially interesting phenomena associated with this ailment are the pathologic characteristics of the lesion, which can be traced directly through the various stages of hyperplasia to malignant change, and the formidable surgical procedures involved in extirpation. Clinically, an acute



FIG. 1.—Multiple polyps of the entire colon, showing several large, pedunculated polyps

abdominal catastrophe may first call the patient's attention to the presence of polyps, which usually means that the condition is widespread, and involves not only the large bowel but occasionally the small bowel. One patient on whom I performed partial colectomy for multiple adenomas had undergone three operations elsewhere for acute obstruction due to intussusception of the small bowel, the exciting cause in each instance was a large, pedunculated polyp. Polyps had also been removed from the stomach and cæcum, but in none had malignancy been suspected.

The following abstracts of cases of congenital polyposis illustrate the pathologic structure present and the surgical technic utilized.

CASE I—A woman, aged thirty-two years, was admitted to the clinic with the complaint of "mucous colitis." She gave a history of having had dysentery for eight months

This was evidenced chiefly by five or six passages of mucus and fecal material in twenty-four hours, blood was never observed in the passages. Her general condition was good, appetite, digestion, and weight were maintained.

Examination revealed that the patient was asthenic and anæmic but gave no evidence of loss of weight. Polyps were noted on digital examination, and on proctoscopic examination the rectum and sigmoid were seen to be studded with polyps. Tissue from one polyp was characteristic of adeno-carcinoma, graded 2. Examinations of stool did not give evidence of ulcerative colitis. Rontgenologic examination demonstrated multiple polyps of the entire colon. The concentration of hæmoglobin was 68 per cent, and erythrocytes numbered 4,480,000.

November 26, 1928, ileostomy was performed, June 20, 1929, partial colectomy was



FIG 2—Polyposis of the colon, showing tendency toward attenuation of cells

performed, the rectal stump being turned in and placed retroperitoneally, and July 3, 1929, the rectal stump was resected posteriorly.

Pathologic examination disclosed multiple polyps throughout the colon and rectum (largest 4 centimetres, near the cæcum) (Figs 1 and 2), one pedunculated polyp in the transverse colon (1 centimetre), one pedunculated hæmorrhagic polyp in the descending colon (1 centimetre), one pedunculated polyp in the sigmoid (3 centimetres), innumerable small polyps, and one adeno-carcinoma, graded 2, involving a polyp in the rectum.

The patient died April 19, 1930, eleven months after the third stage of the operation was completed.

CASE II—A woman, aged twenty-five years, was admitted to the clinic with a history of having had diarrhœa since childhood. Up to three years prior to admission she had had four to five stools daily, but since then had had as many as eight and ten. At first blood appeared in the stool frequently and, more recently, was noted every day and in increasing quantity. Polyps often protruded from the anus. Her general condition,

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appetite digestion maintenance of weight and strength were satisfactory. She appeared to be well developed and but slightly undernourished. There was no loss of weight.

General examination proved negative except for the finding of multiple polyps on rectal examination. Röntgenologic examination revealed multiple polyps, with evidence of malignancy in one. Proctoscopic examination disclosed multiple polyps involving the bowel as far as could be seen and adeno-carcinoma graded 1 involving one of the polyps in the rectum. The concentration of hæmoglobin was 62 per cent.

October 28, 1929, ileostomy was performed, January 23, 1930, colectomy was performed leaving the rectal stump, which was placed retroperitoneally, and February 6, the rectal stump was resected posteriorly.

Pathologic examination disclosed six pedunculated and sessile polyps (Figs 3 and 4), two of the largest pedunculated ones showing beginning carcinoma (Fig 5) (6 by 3 by 3.5 centimetres, and 3.5 by 2.5 by 1.5 centimetres), and innumerable small polyps extending from the ascending colon to the rectum.

The patient recovered satisfactorily and is living and well.

CASE III—A man, aged thirty years, was admitted to the clinic September 26, 1930, because of diarrhœa. His father, mother, three brothers, and a maternal aunt had died of carcinoma of the large bowel, and a sister had died of carcinoma of the uterus. He had a history of attacks of summer diarrhœa, the first of which had occurred in 1922, others had occurred in 1923 and 1925. The attacks lasted two to three months and were attended by an average of ten daily rectal discharges of fæces, mucus and blood. After May, 1928, he was never completely free of diarrhœa and some abdominal discomfort. He underwent considerable treatment for "spastic colitis," "amebic dysentery," and "mucous colitis," and at one time or another took emetine, quinine, thymol, yatren and stovarsol, without apparent relief.

On examination, the patient proved to be somewhat undernourished and ten pounds under normal weight. There was moderate tenderness in the lower part of the abdomen. Proctoscopic and röntgenologic examination disclosed multiple polyps (Fig 6). The concentration of hæmoglobin was 63 per cent, and erythrocytes numbered 4,380,000 in each cubic millimetre of blood.

October 7, 1930, ileostomy was performed, February 20, 1931, partial colectomy was performed to a point near the rectosigmoid juncture, and April 3, 1931, combined abdominoperineal resection of the rectal stump was done.

Pathologic examination disclosed multiple polyps throughout the colon and rectum,

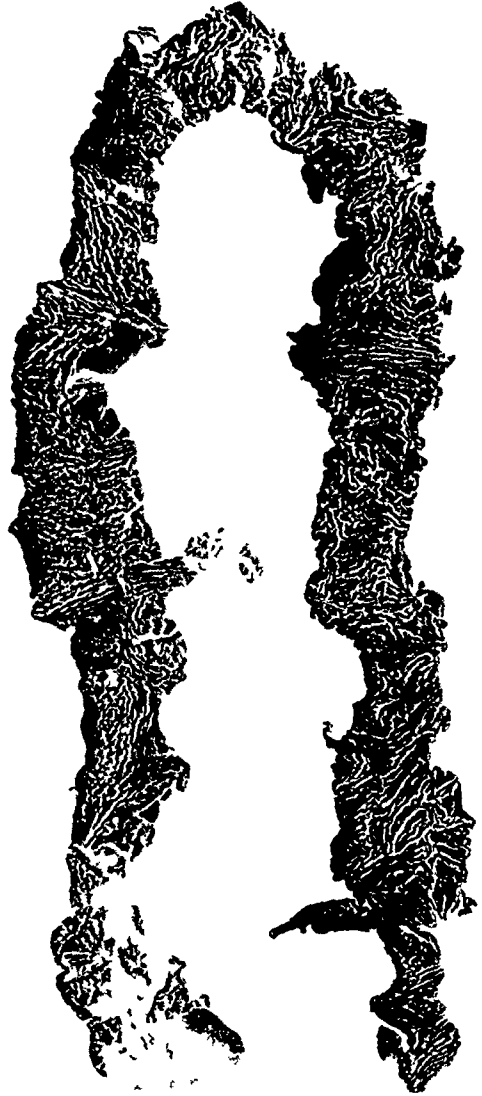


FIG 3—Multiple polyps of entire colon, beginning carcinoma in large, pedunculated polyp.





FIG 4



FIG 5

FIG 4—Single polyp of colon

FIG 5—Carcinoma of sigmoid in a case of multiple polyps of the colon



FIG 6a



FIG 6b

FIG 6a—Polyps obscured by barium filled colon

FIG 6b—Rontgenogram of colon by Weber's modification of Fischer's method showing sessile polyp in descending colon and pedunculated polyp in distal part of transverse colon

## TOTAL COLECTOMY

and many pedunculated and sessile adenomatous polyps, the largest, 2.5 centimetres (Fig 7)

The patient recovered satisfactorily

*Complicated chronic ulcerative colitis and sequelæ* The second indication for total colectomy—The second indication for total colectomy is complicated chronic ulcerative colitis, producing either multiple lesions of the joints as a focus of infection, or resulting in the formation of multiple polyps, which may, and not infrequently do, change into malignant growths. The three patients on whom I performed total colectomy following chronic



FIG 7—Multiple polyps of entire colon

ulcerative colitis of long standing had all been suffering from the effects of absorption from a useless, infected, foul large bowel, containing pus, with resulting multiple arthritic lesions or multiple fistulas, or both. In these cases, all efforts at medical treatment had been only partially successful, and in two of the cases preliminary ileostomy had been done more than a year previously because of the apparently hopeless outlook without side-tracking of the colon.

In reviewing these three cases, it was obvious that the technical difficulties, although more complicated than those encountered in treating the congenital variety of polypoidosis, were not made unsurmountable by formation of abscesses, or firm fixation or infection, and the tendency to subsequent

peritonitis was not a formidable objection. The already existing immunization unquestionably was of great advantage in these cases, and although, in the first colectomy in this series, I broke into an abscess in the glands around the cæcum, there was little reaction following the operation and the patient made an uninterrupted recovery.

Besides the unhappy sequel of long-standing chronic ulcerative colitis, resulting in complications, the superimposition of malignant disease on the polyposis which is secondary to the colitis is important. That this is not unique, although it does happen infrequently, is attested by the fact that in more than 1,100 cases of ulcerative colitis, complicated and uncomplicated, seen at The Mayo Clinic, in twenty-five cases carcinoma has developed in the presence of the polyposis which was caused by the inflammatory lesion. Although perhaps it is impossible to prove pathologically that these carcinomas developed as direct sequelæ of events of the inflammatory process, I think it is a reasonable conclusion that if chronic irritation of long standing initiates carcinomatous changes in a viscus, complicated, progressive, ulcerative colitis of long standing is a factor in malignancy.

The production of multiple polyps as a sequel of chronic ulcerative colitis has been explained by numerous authors as resulting from undermined ulcers which produce a break in mucosal continuity, leaving an overhanging portion, which, being shut off by the regenerative process, forms a pedunculated, polyp-like tumor, with smooth or irregular marginal outlines. The elevations thus formed are surrounded by regenerating mucosa, and, as healing takes place, contraction no doubt leads to their further elevation. The same process isolates the polyps and not infrequently closes the glandular orifices, forming retention cysts. When the polyps become pedunculated the formation of the pedicle is, I believe, the result of the tug on the loose, underlying tissues by the peristaltic action of the bowel, thus producing a true polyp.

Hewitt and Howard, Struthers, and others, in considering the development of polyps resulting from inflammatory lesions, particularly ulcerative colitis, have stressed the importance of good blood supply, which causes the mucosa to be preserved and hastens the hyperplasia and regeneration of glands around the ulcerative processes. I have not been impressed in my cases with the fact that the polyps are found nearest the principal blood supply of the bowel. In all three cases which followed ulcerative colitis, I have demonstrated formation of polyps so diffuse, as to cover the entire intraluminary mucosa of the bowel. The idea of Ewing, Erdmann, and others, that these polyps may be followed through the transitional steps, from thickening and hyperplasia to adeno-carcinoma, is likewise, I believe, a possibility, the actual proof of which is more difficult to procure than in the congenital variety.

The following three cases of multiple polyps, scattered diffusely throughout the large bowel, secondary to chronic ulcerative colitis, are illustrative

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CASE IV—A man, aged twenty years, was admitted to the clinic September 26, 1925. He had had dysentery and passage of blood for nineteen months, had passed a maximal of thirty to forty stools in twenty-four hours, and stated that his condition had been as bad as this for at least 100 days in succession. A diagnosis of amebic dysentery had been made elsewhere, although ameba had not been found.

The patient was found to be acutely ill. His maximal temperature was  $102^{\circ}$  F. He was passing many stools containing pus and blood, and suffered with rectal incontinence. He had lost twenty-four pounds. The abdomen was moderately tender. Proctoscopic examination disclosed involvement of the rectal and sigmoidal mucosa, associated oedema and of tendency to hæmorrhage, and scattered, punched-out ulcers.

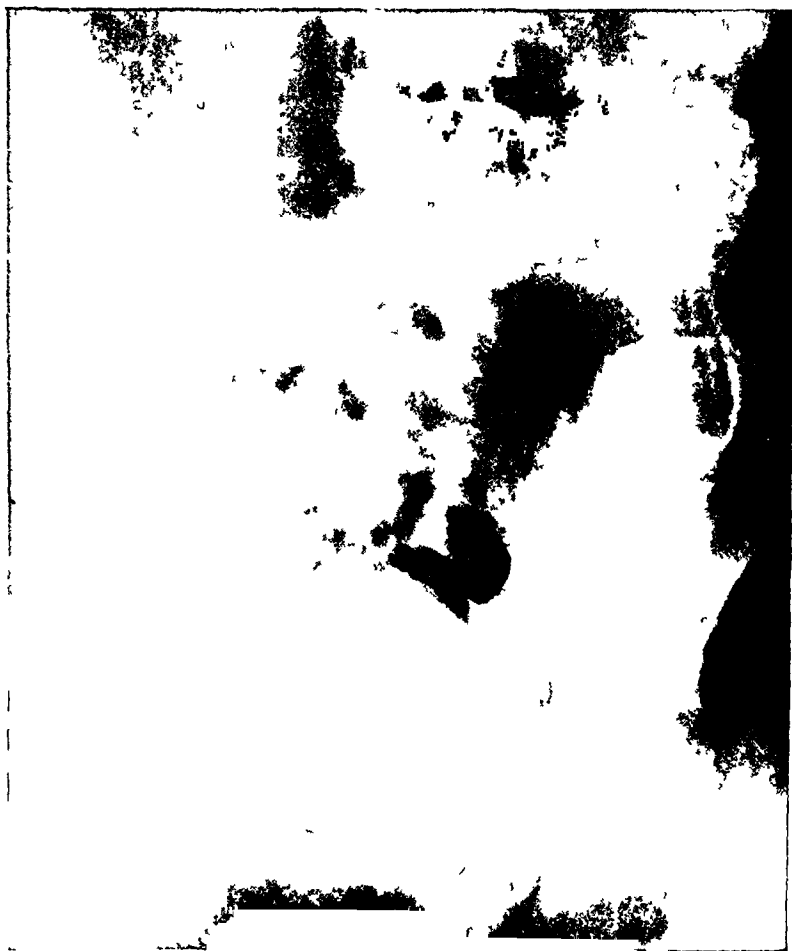


FIG 8—Diffuse ulcerative colitis of entire colon with pseudo polyposis

A diagnosis of chronic ulcerative colitis was made (Fig 8). In the next five months the patient's condition fluctuated. Improvement was slow, but by October 24, 1925, he had progressed sufficiently to be dismissed from observation.

The patient returned to the clinic in February, 1926, much sicker than before, reporting steady failure during the month. Proctoscopic examination disclosed large, sloughing, ragged, undermining ulcers of the rectum, with bridging of the mucosa between them. The condition was very serious, and ileostomy, as an emergency operation, was suggested. Because of the patient's extremely bad condition, however, it was not done. Treatment then consisted of administration of tincture of iodine by mouth, large doses of kaolin, bismuth, opium, camphorated tincture of opium, and small doses of vaccine prepared from the diplostreptococcus which was isolated in practically pure culture from the ulcers in the rectum. The patient improved slowly, and after several

months was able to go home. He came to the clinic again, September 22, 1926. He stated that he had gained thirty-seven pounds in the four preceding months and that he was having six to seven movements of the bowels in twenty-four hours, which only occasionally contained a little blood and mucus. The rectal mucosa contained a few pitted scars and slightly pale. There were many polyps, from 0.3 to 0.7 millimetres in diameter, and from 0.3 to 1.5 centimetres in length, some of them bled easily. The diagnosis was made of polyposidosis following healing in an extremely advanced case of chronic ulcerative colitis. Clinically, the patient was in excellent condition. He was dismissed with instructions to take vaccine subcutaneously. He returned May 23, 1927, clinically well, stating that he had had the best winter since the beginning of his illness. He had gained fifty pounds and looked the picture of health. He had had an average of three bowel movements daily for months and had not seen blood in the stools for at least a month. At this time proctoscopic examination disclosed the signs of healing after chronic ulcerative colitis, polypoid areas, and polyps. The small polyps, seen January 23, 1927, had disappeared. The mucosa between polyps was normal except



FIG 9



FIG 10

FIG 9—Acute colitis with ulceration and desquamation on a basis of chronic ulcerative colitis.  
FIG 10—Chronic ulcerative colitis, partial destruction of mucosa with some evidence of healing for the scars of the infection. A series of fulgurations of rectal polyps was carried out without incident. The patient was then free of symptoms of all intestinal trouble, but because it had not been possible to fulgurate all the polyps at this first visit, he returned in December, 1927 at which time proctoscopic examination revealed that there were still several polyps in the rectum, but that the mucosa was in good condition. The polyps were again fulgurated.

August 9, 1928, the patient returned for observation and scars were noted in the rectum, but there was no ulceration. The lumen was practically normal in diameter. There were no polyps in the areas that had been fulgurated. A month later he returned with rapidly growing nodular lesions on the right arm. Surgical excision revealed hemangio-endothelioma. Treatment with radium and Röntgen-rays followed. There was no evidence of recurrence. During the severe exacerbation of colitis in 1926 the patient had suffered months of disability from what was designated peripheral neuritis. He had, at that time, constant burning pain in the balls of the feet, and later higher in the legs, so that he could not allow bed clothes to touch his feet. Anæsthesia and muscular weakness were present. Recovery from the colitis was accompanied by recovery from the neuritis.

Fig 11—Chronic ulcerative colitis involving entire colon, narrowing of lumen and obliteration of normal haustrations



Fig 12—Chronic ulcerative colitis



From May, 1927, until January, 1929, the patient was free of intestinal symptoms. About January 1, 1929, he had severe influenza, and after three weeks of this illness an exacerbation of the colitis occurred. Treatment was again instituted and gradual improvement resulted. In June, 1929 polyps were again seen through the proctoscope, some of which were large and firm. Operation was decided on because of the exacerbation of the colitis and the potential danger of malignant change in the polyps. October 15, 1929, ileostomy was performed. April 15, 1930 partial colectomy to a point near the rectosigmoid junction was performed and October 14, 1930, combined abdominoperineal removal of the rectal stump was carried out. The patient had gained forty pounds since colectomy.

The pathologist reported diffuse inflammatory polypoid hyperplasia of the mucosa of the colon associated with acute colitis accompanied by ulceration and desquamation on a basis of chronic ulcerative colitis (Figs 9 and 10).



FIG 13—Chronic ulcerative colitis with evidences of healing

Recovery was uneventful and the patient is now attending college.

CASE V—A woman, aged twenty-three years, was admitted to the clinic first in December, 1918, with a history of watery diarrhoea occasionally accompanied by passage of blood for two and a half years. At first there were only three or four daily rectal discharges, but the condition became progressively worse, so that on admission the number of movements had increased to eight or ten a day, and there was some abdominal cramping. During this period the patient lost twenty-nine pounds. A diagnosis of chronic ulcerative colitis was made by proctoscope and roentgenogram (Fig 11).

The patient failed to improve under a medical care which was tried three months, so ileosigmoidostomy was performed February

19, 1919. At the same time, the divided distal end of the ileum, and the proximal end of the sigmoid were brought out through the abdominal wound in order that the colon, thus excluded, could be irrigated. Although there was some abatement of symptoms during the next year, the patient was still disabled. Subtotal colectomy was therefore performed (Figs 12 and 13). Improvement following the procedure was transient, due to the development of severe proctitis, with formation of stricture at the site of the anastomosis, accompanied by diarrhoea and considerable abdominal pain. All medical measures, including numerous injections of polyvalent dysentery serum, failed to cause benefit. Ileostomy was therefore performed January 21, 1925, and May 29, 1929, the rectal stump and remaining portion of sigmoid were removed by combined abdominoperineal operation. The patient made a satisfactory recovery from the operation, and, in spite of subsequent pulmonary hæmorrhages, associated with active tuberculosis, she maintains her normal weight and now leads an active life.

CASE VI—A woman, aged twenty-seven years, came to the clinic first in June, 1924, with a history of bloody dysentery of one year's duration. The trouble began

## TOTAL COLECTOMY

with an acute cold and became progressively worse, so that in the three weeks prior to admission she had had an average of one rectal discharge of bloody, purulent material every fifteen minutes, day and night (Fig 14) Ileostomy was performed August 6, 1924, after the patient had failed to respond to the usual medical measures of irrigation of the colon and administration of sedatives. Improvement followed the operation, but, in the succeeding years, severe, recurrent exacerbations occurred. In March, 1925, in the course of an acute exacerbation, an attack of erythema nodosum occurred. With another exacerbation in January, 1926, she began to suffer from generalized acute arthritis. From then until early in 1930, with each exacerbation of colitis, there was an acute



FIG 14—Chronic ulcerative colitis involving entire colon, marked narrowing of lumen with obliteration of normal haustrations

exacerbation of arthritis. Periarthritic changes increased so that in the last two years she has been totally unable to perform any of her duties.

In 1926, treatment with specific vaccine was begun and the colitis gradually subsided. Non-specific foreign-protein therapy was given for the arthritis, and gradually the acute condition in the joints subsided, but the deformity of the hands, feet, knees and hips made motion almost impossible. In 1929, there was little if any intestinal difficulty, except that the rectum had narrowed so that it was a tube about 1 centimetre in diameter, and retained discharge caused much pain, discomfort, and general upsets.

Because of progressive disability from the arthritis, in spite of the general improvement of the patient I felt that perhaps radical extirpation of a possible focus would bring good results, and total colectomy was performed.

August 6, 1924, ileostomy was performed, March 5, 1930, partial colectomy, and



October 24, 1930, combined abdominoperineal removal of the rectal stump were performed

The pathologic report was hemorrhagic ulcerative colitis with marked narrowing of the lumen and thickened walls (Figs 15 and 16)

The patient has made a satisfactory recovery and has returned to her occupation as stenographer

#### TECHNIC



FIG 15—Hæmorrhagic, ulcerative colitis, marked narrowing of lumen thickened walls

In extirpation of the entire colon, two procedures are available (1) Operation in three stages, consisting of ileostomy, colectomy including the colon down to the rectosigmoid junction, and combined abdominoperineal resection of the rectum, and (2) ileosigmoidostomy followed by colectomy. The latter method frequently leaves a rectum and sigmoid covered with polyps which must be treated by fulguration or other local destructive measures. It has the great advantage, however, of retaining the splendid sphincteric apparatus provided by nature and avoiding the necessity of making an abdominal anus. On the other hand, one is more likely to be compelled to remove the rectum at a subsequent stage after ileostomy and colectomy because of the presence of large and multiple polyps in it, rendering fulguration of uncertain value. Between the two operations one may vacillate, remembering, however, that after ileostomy and colectomy, if it is possible to get rid of the rectal polyps, a feasible step is to implant the ileum into the top of the rectum at a subsequent manoeuvre.

In the six cases outlined, total colectomy was done in three stages. Ileostomy was the primary manoeuvre and colectomy including the colon down to the rectosigmoid the secondary manoeuvre, the third stage consisted of combined abdominoperineal resection of the rectum. Obviously, one should not attempt ileostomy and resection of the colon in a single stage. Ileostomy of itself is a serious procedure because of the disturbance of water balance which follows it. Most of the fluids are absorbed in the right portion of the colon, and to divert the faecal current by ileostomy is to cause such rapid loss of fluid that the patient invariably loses weight and is dehydrated until such time as reestablishment of the physiologic equilibrium takes place. At that time, the ileum begins to assume the function of the right portion of the colon, and the stools become semi-solid or formed.

## TOTAL COLECTOMY

The most satisfactory type of ileostomy is the single-barreled one (Fig 17) in preference to the old-fashioned, double-barreled, or loop ileostomy

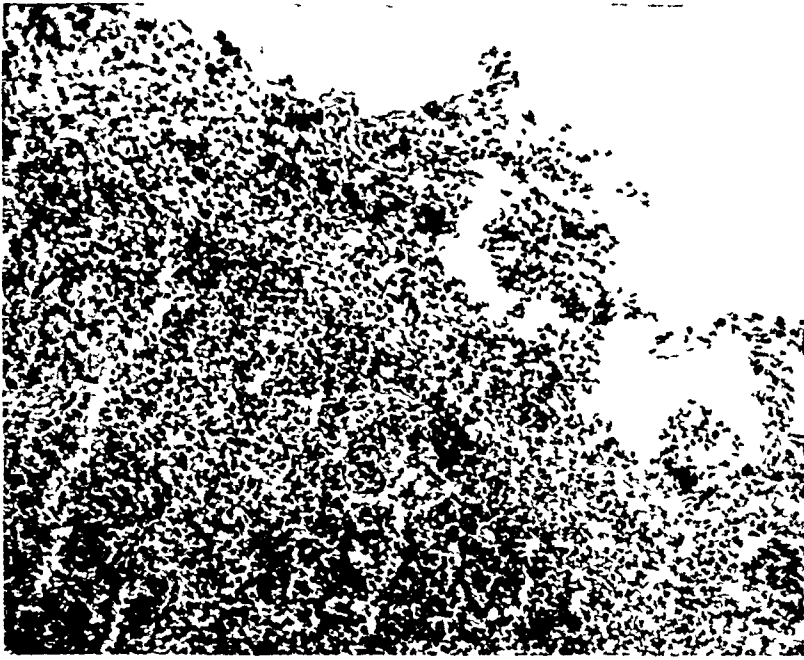


FIG 16—Chronic ulcerative colitis, marked inflammation of submucosa with practically complete destruction of mucosa

I have divided the ileum close to the ileocecal valve, turned in the cecal end, brought the proximal end through a McBurney incision, leaving a clamp on

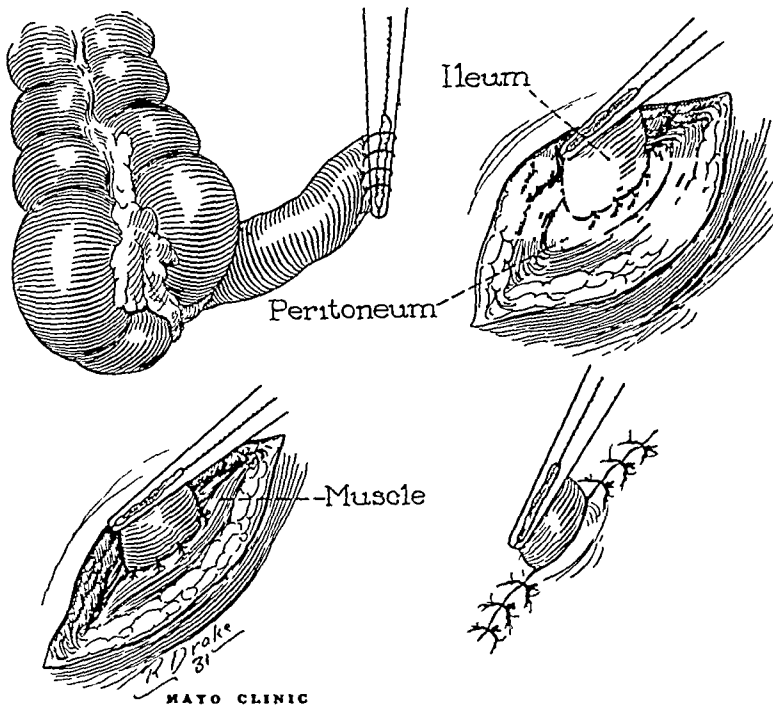


FIG 17—Technic of ileostomy

it, sutured it very closely to the peritoneum, closing the wound snugly around it, and leaving the bowel obstructed for about forty-eight hours. As

one of the steps, I have shut off the space between the mesentery of the terminal portion of the ileum and the lateral parietal peritoneum, just as one would do in performing colostomy involving the sigmoid. This prevents obstruction by loops of small bowel slipping around the structures formed at ileostomy and becoming adherent. Since the ileostomy is made through a small McBurney incision, without exploration, and the wound heals tight a single-barreled stoma results, which is not difficult to care for (Fig 18)

I have found it advantageous to postpone the second stage of the resection for about three months. During this time the patient accommodates himself to the presence of the stoma, gains in weight, the stool becomes semi-solid or formed, and the general condition is much more favorable for a



FIG 18 — After completion of ileostomy

formidable resection than formerly. At the second stage the colon is removed through a long left rectus incision. The dissection begins in the right side of the colon, at the cæcum (Fig 19), and the mobilization is made by dividing the outer leaf of peritoneum, just as one does in resection for carcinoma. The operation may be performed in a much less radical way than for carcinoma, dividing the vessels of the mesentery close to the wall of the bowel, and leaving adequate peritoneum to cover over raw spaces. After the right portion of the colon has been mobilized, guarding against injury to the ureter and retroperitoneal portion of the duodenum, and the vessels are secured and peritonization completed, the dissection is carried along the under-surface of the omentum (Fig 20). That structure is left, but the transverse colon is readily mobilized around to the splenic flexure.

# TOTAL COLECTOMY

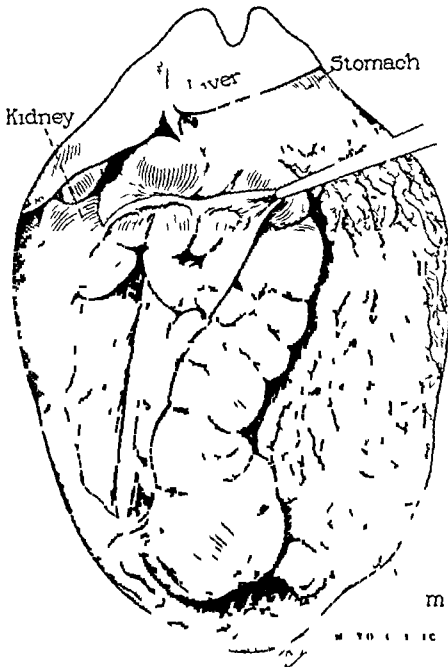


FIG 19

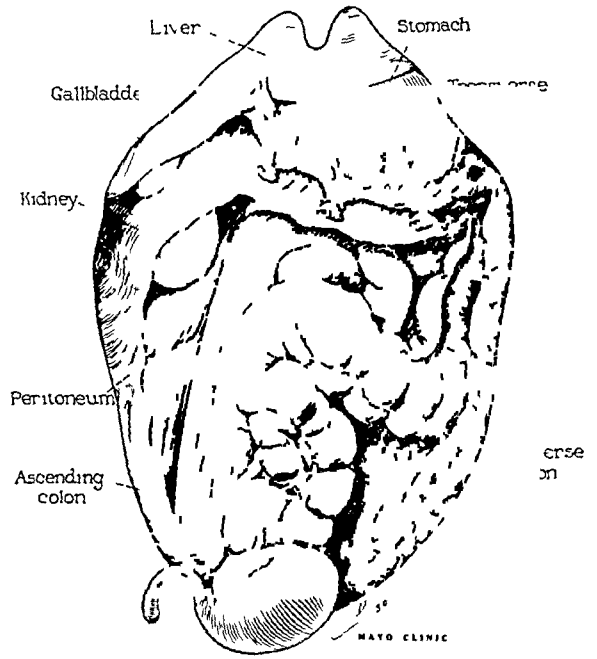


FIG 20

FIG 19—Beginning mobilization of cecum and right half of colon. Incision is made through the parietal peritoneal attachment of the bowel and the dissection is made from without inward.  
FIG 20—Further mobilization of the right portion of the colon and of the transverse colon. The omentum has been divided.

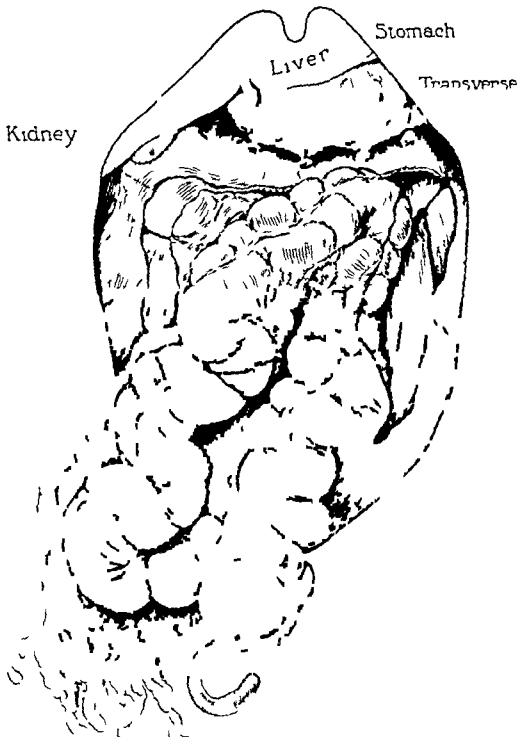


FIG 21

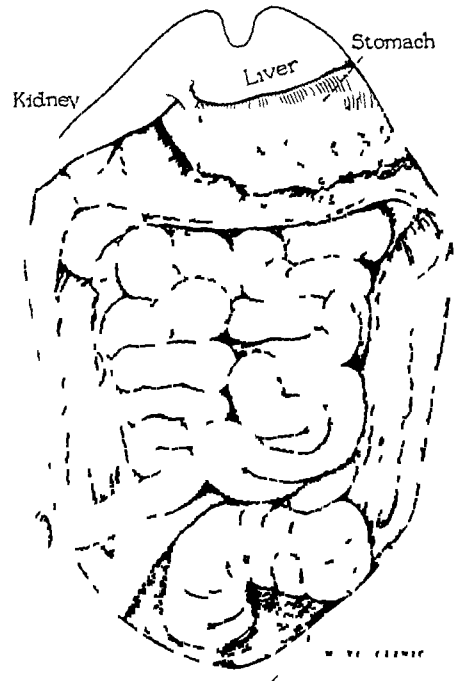


FIG 22

FIG 21—Mobilization of the colon has been carried down to the juncture of the descending colon with the sigmoid.  
FIG 22—Completion of partial colectomy down to the middle of the sigmoid the distal end of which has been inverted. The raw surfaces left by the dissection are closed with a running suture. The abdomen is then closed.

Mobilization of the splenic flexure is the most difficult step in this manœuvre. It is higher than usual and is more likely to be fixed, but by dividing the splenicocolic ligament one can readily clamp off its vessels and proceed downward with the mobilization of the descending colon and sigmoid (Fig 21). The left parietal peritoneal leaflet is divided similarly to the right, these two segments of the bowel are loosened, the blood-vessels clamped out and tied, and the raw surfaces peritonized. I think it is wiser to divide the bowel at about the middle of the sigmoid or at the juncture of the lower and middle thirds of the sigmoid, so as to be sure of adequate vascularization of the end that is to be left in (Fig 22).

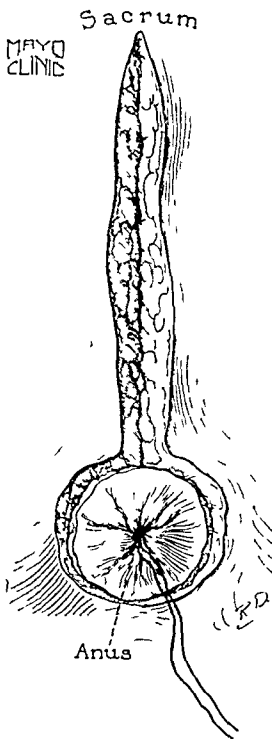


FIG 23.—Posterior incision for removal of segment of bowel left after partial colectomy

When colectomy is to be done for polypoidosis, it is a simple matter to select a point with good blood supply, dividing the bowel between clamps, with cautery, and turning in the lower end, with satisfactory knowledge that there will be small chance of leakage, formation of abscess or other complications. In ulcerative colitis, however, it is impossible to turn in the lower end with a suture, as anyone who has attempted it will readily recognize.

In the first case in which I performed total colectomy for polyposis secondary to ulcerative colitis, when the operation was completed down to the point of division of the bowel, a clamp was put across the bowel and closed, with the result that it cut through the entire intestinal wall, leaving a wide-open colon staring out of the peritoneal cavity. With this experience in mind, it has been my custom to divide the bowel, holding the lower end very lightly, and then suturing over and over, without attempting to turn it out, finally, wrapping it in iodoform gauze and bringing it out through the lower end of the wound. Drainage is instituted, and, fortunately, in these cases of colitis immunization is so satisfactory and complete that chances of peritonitis subsequently are less than in the congenital type of polyposis, in which patients have not had the opportunity of manufacturing their own antibodies.

The third stage of the operation is undertaken subsequently, after adequate rehabilitation which may extend over varying lengths of time for different patients. Certainly, I would not undertake it before two to three months had elapsed in any case, and if the patient were badly debilitated it could be put off longer. This stage of the operation is, in complicated cases, the most difficult of the three steps. Particularly is this true in cases of ulcerative colitis in which formation of abscess or fistulas has been one of the reasons for undertaking the total colectomy. I have been accustomed to doing this third stage after the method of combined abdominoperineal resection of the rectum, starting from behind (Fig 23), mobilizing the rec-

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tum up to the peritoneal fold (Fig 24), but without opening the peritoneal cavity. This is accomplished in the same manner as the ordinary step of posterior resection for malignant growths, and when the rectum is entirely freed from its attachments up to the peritoneum, it is encased in a glove (Fig 25), pushed back into the hollow of the sacrum, and the wound is closed. The patient is then turned on the back, an incision is made low in the median line, the inferior mesenteric vessels are ligated (Figs 26 and 27), the pelvic peritoneum is cut through, and the entire lower segment of sigmoid and rectum is removed through the abdomen *en masse* (Fig 28). This completes the operation, except for the making of a new pelvic floor.

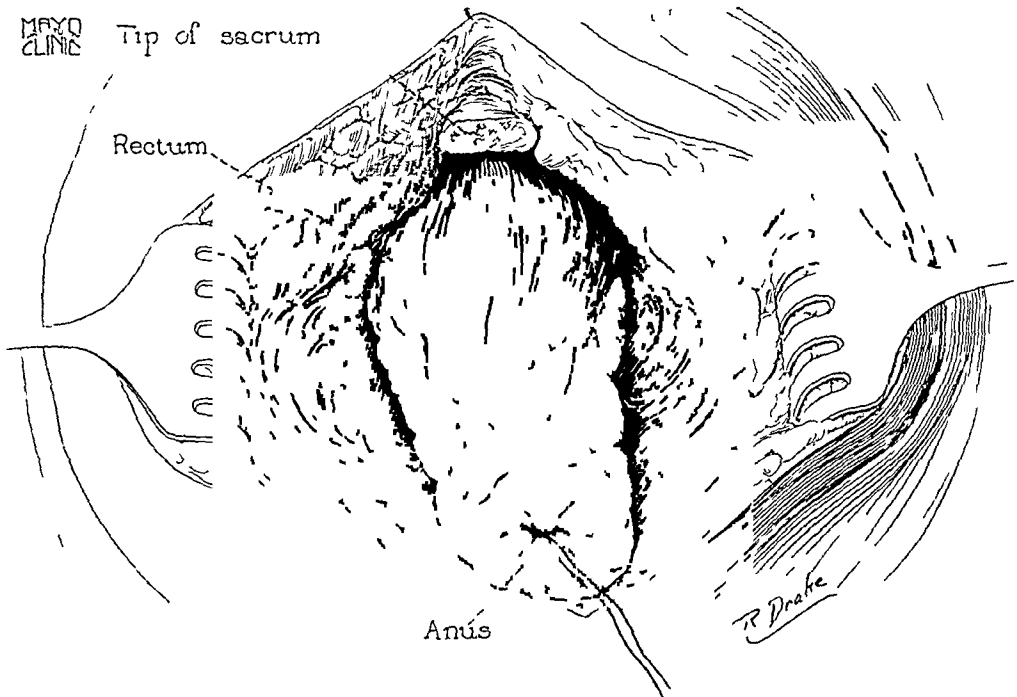


FIG 24—Mobilization of the rectum. The tip of the sacrum has been amputated.

out of peritoneum and instituting drainage posteriorly. Peritonization (Fig 29), in my experience, has never been a difficult step, even in operating on men. It is possible to mobilize the lateral parietal peritoneum and to utilize the peritoneum from the bladder to such an extent that the floor is readily completed without much tension. In operating on women it is a very simple matter to complete the peritoneal floor by the use of the broad ligaments in addition to the lateral parietal peritoneum.

Drainage is instituted after the abdomen is closed. About half of the silkworm sutures which have closed the posterior wound are removed, and a gauze tampon and rubber-tube drain are inserted. This takes care of slow oozing which may be present in the large, wide-open pelvis, and also siphons off the serum which necessarily will collect. The tampon is removed about the seventh or eighth day, after having been loosened by irrigations and by the use of peroxide of hydrogen. It is astonishing how

quickly some of these large cavities will close and contract down to a small drainage tract which, after several weeks, entirely disappears. One patient who underwent combined abdominoperineal resection of the rectum I dismissed on the nineteenth day with a draining sinus which was comparatively small, but the usual patient ordinarily takes about four weeks in the hospital after this stage of the operation.

Rehabilitation after these formidable procedures is slow and adequate dietary measures and other steps for increasing the patient's resistance are

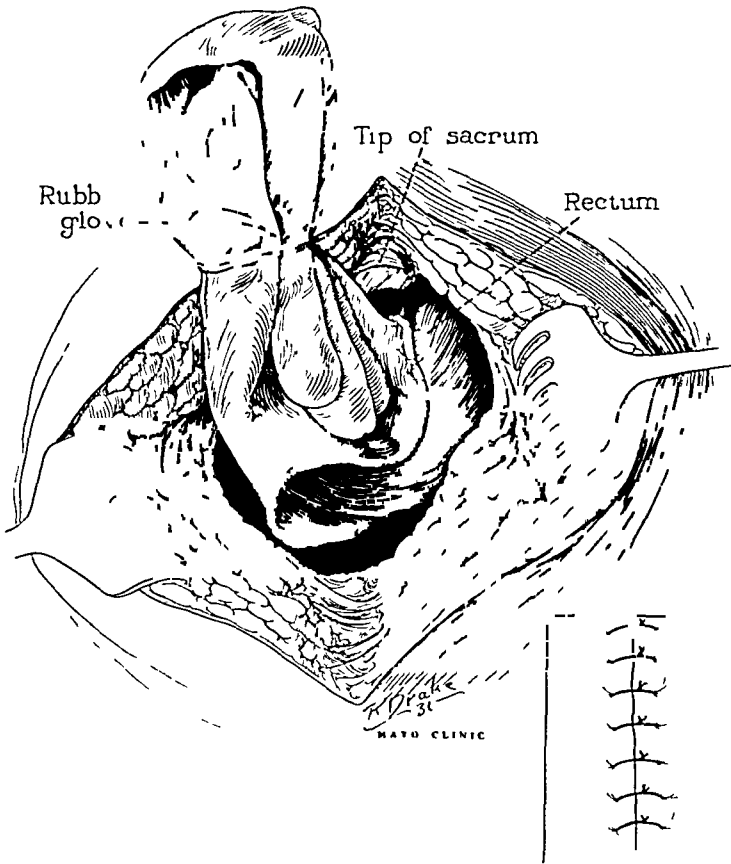


FIG. 25.—Completely mobilized rectum encased in rubber glove. Insert shows wound closed after segment is dropped back into hollow of sacrum.

urgently indicated. The immediate post-operative care of these patients, following the third step, is similar to that following any combined abdominoperineal resection.

In this series of six cases there has not been a death from operation.

I particularly want to call attention to the advantages of graded removal of the large bowel and rectum when its extirpation is necessary, and to emphasize the thought that polypoidosis, and particularly the congenital variety, is a potentially malignant condition which warrants radical measures before metamorphosis into carcinoma has taken place. As for the other indication for resection, complicated chronic ulcerative colitis, it is evident that the

## TOTAL COLECTOMY

question of focal infection must be a very urgent one before such radical surgical measures can be undertaken, but here, too, polypoidosis or pseudo-

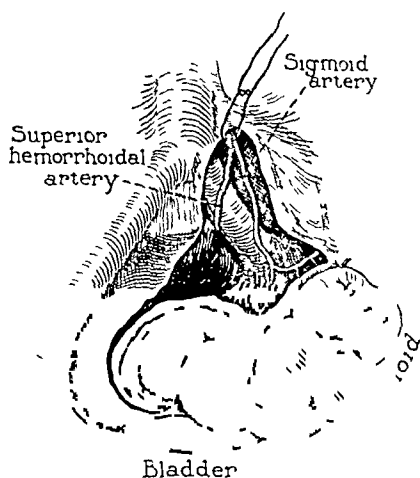


FIG 26

FIG 26—Anterior approach following posterior mobilization of rectum. Ligation of blood vessels to sigmoid and rectum.

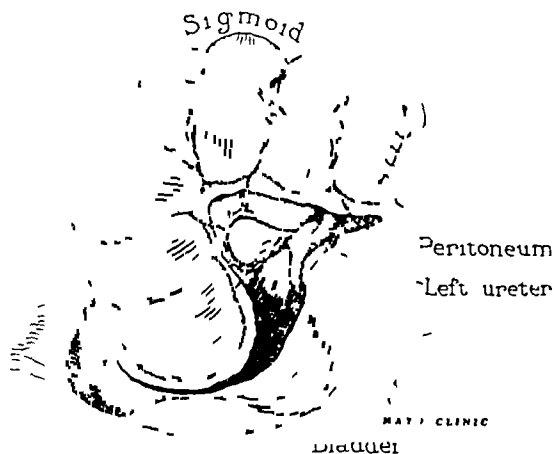


FIG 27

FIG 27—Division of peritoneum for mobilization of sigmoid and exposure of left ureter.

polypoidosis, whichever one chooses to regard it, unquestionably is a forerunner of malignancy in certain cases.

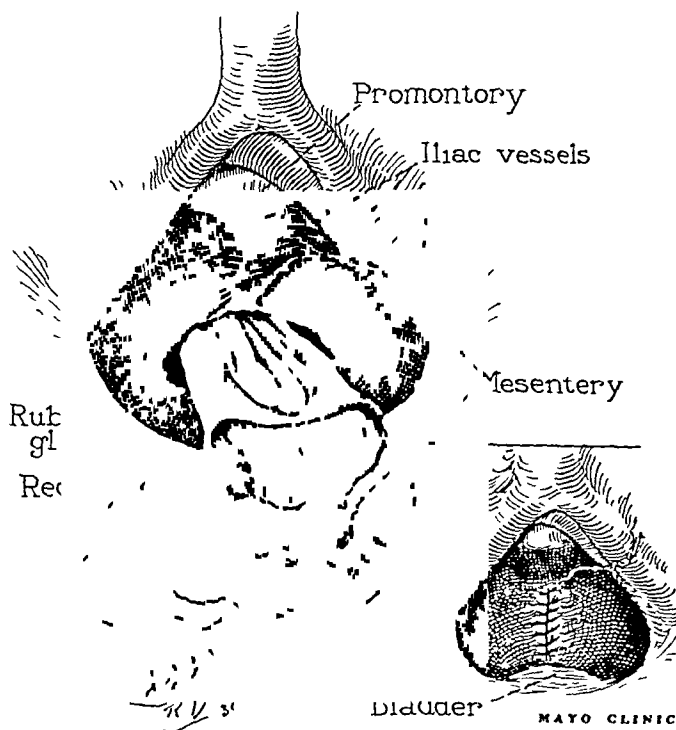


FIG 28—Entire rectum being lifted out of hollow of sacrum. Peritonization of pelvis completed.

DISCUSSION—DR FRED B LUND (Boston) showed a lantern slide in illustration of Doctor Rankin's paper presenting the effect on the large intestine of a very long constituted ulcerated colitis.

The patient was a little woman upon whom an ileostomy was done nine years ago.



She had ulcers, and Doctor Lund hoped, as had been in other cases, that putting the colon at rest would cure this ulcerated colitis, but the ulcers never healed. Although she had bloody stools and mucus for nine years, she kept very well and did all her housework. One day she turned up with a very large abdominal tumor in the upper left quadrant. She had grown very thin, her red blood count was down to just a little above two million. He supposed that she had developed a carcinoma. He did an exploration and found that there was a tremendously inflamed colon and the tumor was the inflamed, swollen, thickened omentum. With a transfusion before and after the operation it was easy to remove that colon. She recovered and has since done very well.

As to Doctor Eggers' observations on diverticulitis, the speaker was of the opinion that whenever one finds a left-sided appendicitis in a fat man of about forty, which feels like a

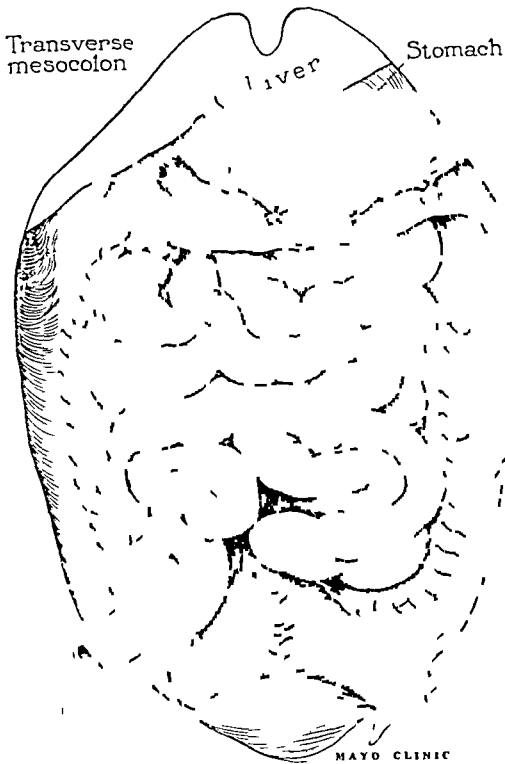


FIG. 29.—Total colectomy completed. The raw surfaces left by dissection are closed with a running suture. A new pelvic floor has been made out of peritoneum.

tumor, one can be sure it is a diverticulitis. In rare cases of appendicitis where the tenderness is on the left, the appendix goes down to the bottom of the pelvis, or the tenderness on the left may be due to inflammation or obstruction making the external coils of the ileum distend. But one can generally tell these diverticulitis cases. He recalled the case of a woman who had an abscess about the size of a pigeon's egg between the layers of the mesentery of the sigmoid. That was drained. The abscess worked down into the pelvis, where it was drained through the rectum. But it never seemed to be drained sufficiently, and after eight months of watching that woman fade away she died.

Another case shows what can be done in severe cases of diverticulitis by multiple operations. This was a very fat old woman of sixty-five, with an acute intestinal obstruction, which was much distended, in which immediate operation had to be done. A left-sided incision was made and an enormous sigmoid was brought out. The intestine was opened above it. The next day feces poured out, and here was this great mass on the outside of the abdomen. But it did not

feel like a carcinoma, it was pretty smooth. A week or ten days later that was cut off according to the Mikulicz procedure and an enormous amount of pus came out from between the layers of the mesocolon and also around it. If one hadn't waited until that was walled off one would have lost the patient. Her heart went on all right, although she had an intermittent pulse, and the clamp was put on. Subsequently, without ever opening the peritoneum again that whole thing quieted down and it was possible to suture the bowel. It held, and she went home in excellent condition, with her heart better than it had even been for years.

Suppuration between the layers of the mesosigmoid is one of the worst things which may happen in these cases of diverticulitis, and it has been his experience that when the abscess has been opened, they subsequently come to a resection. In cases where there is a multiple diverticulitis, but only one section is inflamed, one can disregard all the area that is not inflamed and resect the inflamed area as if it were a carcinoma, and they get well.

## TOTAL COLECTOMY

DR DANIEL F JONES (Boston) said that in regard to diverticulitis, he did not think many require operation. Most of these cases would get on better with an oil or diet régime, such as Doctor Eggers gave, rather than with a resection. A resection in these cases is a very serious operation, too serious for the condition, because a great majority of the cases go on. He had seen an abscess opened and the sinus drained for a long time, it is true. But in quite a percentage of the cases they close.

Doctor Rankin in his paper has brought out, and spoken of, an operation which ought to be done much more often, and that is an excision of the colon for polyposis. These cases go on, he was perfectly sure, and die of carcinoma unless this is done. It is, therefore, reasonable that these cases should have the colon removed when they are found.

In a recent case, in a girl of twenty-three, who was operated upon for carcinoma of the rectum, when they took out the rectum they found carcinoma of the sigmoid. They took that out and found three other carcinomas along the colon. In other cases it is the same. There are many of them. He was sure that the colon should be removed in these cases.

As to chronic ulcers and colitis—he was not sure about the carcinoma form of these ulcers, but he was quite sure that the colon should be taken out in a few of these cases of chronic ulcerated colitis. It can be done without a great mortality. Of course, the real mortality comes before the operation, from intestinal obstruction.

He judged from the X-rays presented by Doctor Rankin that he has taken out the whole omentum. It is quite easy to leave the whole omentum. The omentum is attached to the transverse colon by a very thin peritoneum and very few vessels. By freeing the omentum from the transverse colon and turning it up, it can be left very easily and makes a very good cover for the small intestines, and does help to prevent obstruction.

DR J SHILTON HORSLEY (Richmond, Va.) remarked that one of the chief dangers in resection of the colon is sepsis. This may be avoided partly by the technic employed, but there are other measures in the preparation of the patient that are even more important than the technic. A preliminary preparation of the patient, as Doctor Rankin has so often emphasized—by giving a diet composed largely of carbohydrates and fruit juices and by injections into the peritoneal cavity either of a vaccine or dextrose—is even more important than the method of operating.

Another highly valuable measure is reduction of the quantity and virulence of the intestinal bacteria by giving the bowel rest. When the lesion is in the transverse or left colon this can be done by a muscle-splitting incision on the right side, bringing up the cæcum and ascending colon well into the wound, dividing the external layer of the mesentery to this bowel if necessary, and placing a glass rod under the bowel. If there is marked obstruction, a rubber tube can be introduced at once, and after two or three days a longitudinal incision is made in the bowel on the oral side of the glass rod. This is the old method of doing an enterostomy, especially as practised on the sigmoid for cancer of the rectum, and is a useful procedure. By this means the colon is given complete rest—not merely the partial rest that would occur from the introduction of a catheter with the bowel in the peritoneal cavity. After ten days the resection can be done with comparative impunity.

Another cause of trouble is the poor blood supply in the large bowel. This is a well-known anatomic fact and frequently causes leakage along the suture line. Often after the mesentery to the affected loop of bowel has been divided and tied it is assumed that the circulation at the proposed site of resection is normal. If, however, the mesentery is cut at its junction with the bowel it is often found that here is no circulation, or it is very feeble, at this point. It seems a good plan to continue this division of the mesentery at its junction with the bowel until a spouting point is encountered in the mesentery. Here the resection can be made with an assurance of circulatory competence.

Doctor Horsley uses the basting-stitch technic of Doctor Kerr. It is ingenious and attractive, and in many cases it has worked out well. In two of his patients, however, it was not satisfactory and mortality resulted. The objections to this basting-stitch technic are these: (1) In placing the basting stitch it is sometimes difficult not to penetrate the bowel. If the bowel is penetrated the stitch is infected, and when it is pulled out it spreads the infection along the track of the stitch and in the peritoneum. Even when carefully inserted there is sometimes eversion of the mucosa. (2) Occasionally the stitch hangs and it is difficult to remove. This traction on the basting stitch may disarrange the permanent sutures. In one case he found it necessary to open the bowel in order to remove the basting suture, and the patient died. (3) A large amount of diaphragm is turned in, so obstructing the lumen. This consists not only in the amount of tissue already turned in by the basting stitch, but in the tissue between the basting stitch and the permanent suture, even assuming that only one row of permanent sutures is used. Unless the calibre of the bowel is large this diaphragm may produce complete obstruction, and while such obstruction may be overcome in experimental animals such as dogs with strong intestinal muscles it is of serious consequence in man, as he knows from personal experience of a fatal case. (4) The mucosa in the basting-stitch technic is not accurately approximated. While this is of no particular consequence in a small bowel whose contour is smooth when there is a small amount of diaphragm, in the large bowel where the contour is irregular and when a deep diaphragm is turned in by the basting stitch the fecal matter may lodge in between the mucosa of the two ends of the bowel and cause trouble. A narrow, firm line of apposition of the whole bowel wall (as often observed after the Murphy button) gives the most desirable eventual results.

If the colon is drained for at least ten days before the resection by a complete enterostomy opening, the resection can be done with almost as much safety in the colon as in the upper small intestine under ordinary conditions. The mucosa and the whole bowel wall are sutured with linen or silk from *within* as far as possible, this including the mesenteric portion, and then the remaining portion can be whipped over from without if necessary, tying the suture to the original end. Over this is placed a series of interrupted mattress sutures of catgut, and after tying them the ends should be passed through some adjacent peritoneal covered fat, such as the omentum. The enterostomy should not be closed for at least ten days after the resection.

DR W E SISTRUNK (Dallas, Tex.) said that he had always felt, in the work he had done, that the high mortality which came from operations on the colon came, in many instances, from the effort to accomplish in one operation something which really should be divided into several different stages. A great many patients have been lost through failure to appreciate that a patient can stand so much and no more, and that if one does try to divide operations into stages, although a good deal of time is lost to the patient, that many times the patient may be sent home well instead of the wrong way.

He had always felt in resecting the ascending colon that he obtained better results by carefully preparing his patients beforehand, in order to get the bowel as empty as possible, then through a left incision by making an ileocolostomy. This ileocolostomy allows drainage below the loop which may be partly obstructed and puts it, to a great extent, at rest. This does away, to a great extent, with the acute infection which surrounds practically all carcinomas of the bowel.

After a period of two or three weeks has passed, and the patient is up and about, one can go back to a perfectly clean incision on the right side and resect the bowel, after it has been mobilized, and then have nothing to do but close off the two ends of the bowel, the ilium end and the end of the transverse colon, and the operation is completed. Many times this can be done without any draining, and only a delay of two or three weeks is occasioned by this step.

In dealing with acute sigmoiditis and with diverticulitis, one must be extremely careful. A great many of these patients who have had slight attacks, indicating trouble from a diverticulum, will get along very nicely indeed through care, as far as their diet is concerned and through the use of mineral oil and other measures to obtain bowel movements and to prevent constipation. In acute cases it would be extremely dangerous to attempt anything in the way of a surgical procedure until the patient has developed an immunity to this infection which has become acute. After a period of seven to ten days, or possibly twelve days if it becomes necessary, one could drain the abscess and then leave the case alone and see whether or not something would be necessary later on. If one finds an obstruction present, he much prefers, in preference to attacking the local area to make a colostomy of the transverse colon and suture the lips of the bowel together so it can be closed later. After a period of two, three, four, six, or seven months, one can go back and do whatever seems necessary to the sigmoid.

Doctor Rankin's technic, by doing the operation in two stages, is certainly the soundest way to do an operation of that sort. It is certainly a most formidable operation but we see cases that have polyposis which extends throughout the bowel which have to be cared for in some way, otherwise malignant polypi develop and they lose their lives. On the other hand, there are certain cases of ulcerated glands, cases that have a great deal of trouble from the bowel that is left, which evidently have a streptococci infection which extends to the bowel. They are very miserable even after an enterostomy has been made. The operation has a field of usefulness.

DR LINCOLN DAVIS (Boston) recalled a case that had a resection of the right side of the colon about five years ago, for carcinoma of the cæcum. At the point where the transverse colon was severed the bowel was found to be full of little polypi. A lateral anastomosis was done, and the man left the hospital. He has been under observation now for five years. With a proctoscope one can see multiple polypi scattered throughout the rectum, as far up as can be seen. One or two of these have been removed and examined and found to be benign. Although advised to have a resection of the remainder of the large intestine, the man demurred. He has been very comfortable. Occasionally he passes a little blood, but otherwise has no symptoms. Undoubtedly he will develop carcinoma eventually.

The point is that he has had five good years, without an artificial anus. If a total colectomy is done he would have to have an artificial anus. He would rather run the chances of developing a carcinoma than have a resection with an artificial anus.

DR F. N. G. STARR remarked that some years ago when he was making very accurate records and everything of all of the gall-bladder cases cultured, and in an analysis of 600 of these there was 6 per cent that presented a culture of staphylococcus. All of these patients had suffered from diarrhoea, all of this 6 per cent. In some of them there was observed at the time of removing the gall-bladder that there was a certain amount of colitis. They all cleared up after they had the gall-bladder removed.

Following that experience a woman arrived who had been in England some ten months previously and upon whom Doctor Shenstone did a colostomy for a very pronounced ulcerative colitis. She came to me to see if it was time to have it closed. It wasn't, there was still a very active ulcerative process going on. Upon going over her he found a tenderness over the gall-bladder, and upon examination found it was a non-functioning, or slow-functioning, gall-bladder. He took it out, and the pus discharging from the colostomy opening ceased three weeks after the operation. The colostomy was closed three months later and she has been well ever since.

Possibly that may, in certain instances, be a cause of some of these cases.

He had been struck, too, sometimes in opening an abdomen years after a previous operation to find out the reconstructive powers of the intestinal tract. For instance, a woman upon whom he did a complete colectomy for ulcerative colitis some years ago returned at the end of six years complaining of great frequency in menstruation. Upon X-ray examination he found a definite kink at the point of the anastomosis of the ileum.

to the sigmoid, which apparently was adherent to the top of the bladder. He reopened her. Although the entire sigmoid had been removed, he found little bunches of fat running up the ileum for about six or eight inches and one of these had become adherent to the bladder and produced the kink. The release of that immediately gave her complete relief.

DR HARRY H. KERR (Washington, D. C.) differed from Doctor Horsley as to the disadvantages, or the weakness, of the basting stitch.

The question of turning in too much bowel depends upon three factors. How much has been crushed in the clamp, how far the basting stitch is taken from the clamp, and how far the anastomosing stitch is placed from the basting stitch.

In the large bowel the amount of invagination is not of as great importance as in the small bowel. In the small bowel, the higher you go the more the partial diaphragm interferes with the lumen of the bowel and the greater the danger of obstruction. In operating on children, or the small bowel of adults, we divide the bowel at an angle to its axis. If it is divided at an angle of 45 degrees, the circumference of the stoma is twice the circumference of the bowel and the danger from invagination disappears.

If one uses a single anastomosing suture one reduces the amount of the invagination. The question of the amount of invagination is easily controlled and should never cause obstruction. By the use of a single anastomosing suture the amount of invagination is materially reduced.

As to the difficulty from breaking the basting stitch in my earlier experience, I had a basting stitch break but I now use stout Pagenstecher linen. Stout waxed Pagenstecher linen, I think, should be used.

As to the possible advantage of suturing the mucous membrane, he does not believe that holds because he does not believe you can suture the mucous membrane and get primary union. We all know that intestinal union is not by the healing of like tissues but by the agglutination of the peritoneum that subsequently becomes organized.

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—a mortality of 37·9 per cent and eighty-five had radical resections, among whom were seventy recoveries and fifteen deaths—a mortality of 17·6 per cent. It is with this group of eighty-five radical resections that this report is concerned.

A general principle so widely accepted that it needs no support is that of the expediency of a preliminary proximal drainage operation, especially if there is any degree of obstruction. This is borne out by the following figures:

Resection with preliminary cecostomy or colostomy	35
Recovered	32
Died	3
Mortality	8·5 per cent
Resection without preliminary drainage	50
Recovered	38
Died	12
Mortality	24 per cent

In other words, taking all cases of radical resection, the mortality was nearly three times higher among those without preliminary drainage.

Carcinoma of the right colon anywhere between the ileo-cæcal valve and a point beyond the hepatic flexure, is quite unanimously considered to be best treated by removal of the whole right colon and anastomosis between the terminal ileum and the transverse colon. This is because (1) removal of a lesser part hardly gives a wide enough margin of safety, (2) the proximal colon being incompletely covered by peritoneum and having a good deal of attached fat or membranous veils is less amenable to anastomosis, (3) the ileum has a rich blood supply which minimizes the liability to suture line necrosis, and (4) the operation is relatively easy. Opinion does differ, however, as to how the anastomosis shall be made—whether end-to-side or side-to-side, in one or two stages, and whether it should be accompanied by a proximal safety-valve ileostomy of some type. Bell,<sup>1</sup> Judd,<sup>2</sup> Rankin,<sup>3</sup> and others advise an end-to-side ileo-transverse colostomy with simultaneous safety-valve ileostomy by a small rubber tube, Goetsch<sup>4</sup> advises a three-stage procedure comprising first a cecostomy, then an ileo-transverse colostomy with omental interposition and finally at the last stage, an excision of the right colon. The great majority of writers prefer a single-stage procedure and this has been the usual method in the present series. A total of twenty-one patients with carcinoma of the right colon was operated on, with sixteen recoveries and five deaths, giving a mortality of 23·8 per cent. The operation of choice was end-to-side anastomosis of the terminal ileum to the transverse colon, which was done eleven times with one death, a mortality of 9 per cent. The fatal case involved a multiple resection of the right colon, a part of the gall-bladder and duodenum, and was followed by death in nine hours from shock—a case in which obviously the method of suture was not at fault. A side-to-side anastomosis was done seven times with three deaths,

a mortality of 42·8 per cent. Two of the patients who died had extensive metastases, one of whom developed peritonitis and ileus, but apparently rather from handling the infected neoplastic bowel wall than from a leaking anastomosis, which could not be demonstrated. The third fatality occurred from cardiac failure in 24°. In addition to these preferred methods, there was one instance of successful resection of the hepatic flexure followed by side-to-side ascending-transverse colostomy with simultaneous cæcostomy, and one successful case of end-to-end anastomosis of ileum to transverse colon—made easy by the great distention of the former. The fifth fatality in this right-colon group was due to shock and peritonitis following an emergency Mikulicz procedure made between limbs of the ileum and transverse colon necessitated by the collapse of the patient on the operating table. In one of the successful end-to-side anastomoses in a patient with extensive hepatic metastases a simultaneous ileostomy was done. The average period of hospitalization of patients upon whom successful right colectomy was done was 22·3 days. The analysis of the records of this group does not suggest that any of the five fatalities could have been avoided by a provisional ileostomy. Four of the patients showed extensive metastases and one had chronic cardiac disease, and in the one instance where peritonitis was a factor no leak could be demonstrated at autopsy. The conclusion seems justified that the best method of handling carcinoma of the right colon is by resection of the entire right colon, with end-to-side anastomosis of ileum to transverse colon, without preliminary or simultaneous ileostomy. It is possible that in selected cases a fractional method in stages as suggested by Goetsch might be useful.

In the transverse colon we are dealing with a portion of the bowel which is mobile, entirely covered by peritoneum except for the omental attachment, possessed of a good but not rich blood supply, and containing semi-fluid or pultaceous fecal contents, which may become inspissated and lumpy in the presence of marked stasis. Obstruction is not common, partly because the fecal stream is fluid enough to pass through a small opening, and partly because the superficial position of this portion of the bowel makes it likely that the tumor will be noticed by the patient or his physician before the symptoms are advanced. The bowel being mobile by virtue of its long mesentery, resection can be carried out without great difficulty—on the other hand, these tumors seem to be peculiarly liable to involve the greater curvature of the stomach and to a less extent adjacent coils of intestine. The problem here is to decide whether a primary resection shall be carried out, and if so, by suture anastomosis or by the Mikulicz procedure, and whether by either method there should be a simultaneous proximal safety-valve cæcostomy or colostomy, or a preliminary one made some days before the resection.

The advantages and disadvantages of some of these methods must be carefully considered. With most authorities a cæcostomy is the ideal form of temporary safety-valve. Among its advantages are that it is certain to be proximal to any colonic lesion even if the exact situation of the latter is not known, the location of the cæcum is very constant and the operation

usually easily done, and it is likely to close spontaneously if properly made. Among its disadvantages are the fact that it usually only diverts a small portion of the faecal stream, and thus while relieving the strain of gaseous distention on the resection suture line, it nevertheless permits it to be constantly soiled, and does not do away with the occurrence of distal peristalsis which may interfere with healing, if it does happen to drain most of the intestinal contents, the patient's nutrition may be considerably interfered with, finally, although a cæcostomy is supposed to heal spontaneously, it does in fact sometimes require operative closure. A cæcostomy which completely diverts the intestinal contents would be most difficult to make on account of the fixation and size of the cæcum and would seem to be most unwise on account of the patient's nutrition, although Gordon-Taylor<sup>5</sup> is an advocate of it. A similar type of safety-valve in the proximal transverse colon would present many of the same advantages and disadvantages, although permitting more absorption of the intestinal contents, but a colostomy of permanent type at the same point, made by bringing a loop outside the abdomen, would completely divert the faecal stream, and would permit cleansing of the field before, and complete rest after, the resection.

The question whether a resection may be most advantageously done by immediate suture or by the Mikulicz procedure method is one deserving careful study. The latter is widely advocated and practised, but authorities differ in appraisal of its merits, as is shown by the statement of Coffey<sup>6</sup> "It is probable that there has never been so important a principle introduced into intestinal surgery as the Mikulicz principle," and that of Bell<sup>1</sup> to the effect that the operation of Mikulicz should be abandoned owing to length of hospitalization, high percentage of recurrence, danger of vascular thrombosis and post-operative herniation. It should be clearly understood what is meant by the Mikulicz operation. As originally proposed by von Mikulicz, it consisted of drawing out a loop of mobilized colon with the tumor at its apex, closing the abdominal wall about the afferent and efferent limbs, and after Nature had sealed off the peritoneal cavity, cutting away the loop including the tumor and its mesentery, and subsequently destroying the spur between the limbs by crushing forceps and encouraging the retraction of the bowel ends and spontaneous closure. It is obvious that this operation did not permit resection of the tumor by a wide margin, or complete removal of tributary glands, and as a result recurrences were common, and there were many instances of tumor implantation in the abdominal wall. As usually practised at present the method has been much modified. The colon is mobilized to the necessary degree, an adequate resection of bowel and mesentery is done, the two limbs are sutured together bringing peritoneal surfaces in apposition, and the ends are brought out of the abdominal wound, subsequently the spur or partition between the limbs is destroyed by pressure clamps, and the faecal fistula allowed to close if it will or be repaired by secondary operation. Rankin<sup>3, 7</sup> states that the Mikulicz procedure is usually only a palliation, mentions the danger of infection and peritonitis and the



liability of the ends to retract as late as seventy-two hours, and states that in 183 cases at the Mayo Clinic the mortality was 9.6 per cent to which must be added 7 per cent of recurrences in the abdominal wall. He says that general statements as to its mortality and end-results are not confirmed by studying a group of cases. He finds useful application of the method in a few selected cases. Gehrels<sup>8</sup> states that the Mikulicz procedure seems to have the lowest mortality and advocates a modification which avoids the "unsurgical" crushing of the spur which may lead to pain, hæmorrhage, stenosis and peritonitis, and substitutes a painstaking freeing of the double-barrel colostomy several weeks after the resection, with end-to-end suture, not hesitating to enter the peritoneal cavity. Gordon-Taylor<sup>5</sup> asserts that the Mikulicz type of procedure has the lowest mortality but advises a preliminary cæcostomy of a type to divert entirely the fæcal current, which would seem to imply that one of the chief advantages claimed for the Mikulicz method—free drainage of the bowel from the proximal opening of the double-barrel, is in fact, negligible. Sistrunk,<sup>9</sup> considers the operation as the safest method in certain cases of carcinoma in the mobile portion of the colon, but the contraindications which he gives limit its employment to a few cases, for he says it is unsuitable for adherent growths with infection of the bowel wall and adjacent tissues, for large growths associated with infection, for obstructing lesions, and for growths in the sigmoid in obese patients with short mesenteries. He recommends for some of these cases a modified procedure preceded by a transverse colostomy. Richardson,<sup>10</sup> Bolling,<sup>11</sup> Lockhart-Mummery,<sup>12</sup> de Martel<sup>13</sup>, all advocate a modified Mikulicz-type procedure in certain cases, on the other hand, Grey-Turner<sup>14</sup> apparently gives the method no consideration.

The alternative to an operation of the Mikulicz type is resection of the lesion, with immediate anastomosis by either simple suture or by one of the two-score-odd aseptic methods, which as Rankin says, have been described, either as a complete operation, or accompanied or preceded by some form of temporary intestinal drainage. The experience at the Peter Bent Brigham Hospital is offered as an aid to understanding and solving these disputed points.

Eleven resections of the transverse colon have been made with two deaths—a mortality of 18.1 per cent. Nine of these resections were made by direct suture anastomosis, end-to-end—of these eight recovered and one died, two were made by the Mikulicz method, of whom one recovered and one died. Among the eight successful suture anastomoses three had a preliminary safety-valve cæcostomy and five did not, the hospitalization of these patients averaged 31.2 days. The one fatality was due to adhesions of the small intestine to the suture line, with kinking and obstruction, this patient had had a preliminary cæcostomy, and inasmuch as the adhesions were presumably due either to local infection at the time the anastomosis was made, or to subsequent slight leakage, it may be argued that if a proximal colostomy of complete type could have been made, to divert completely the fæcal current and permit cleansing

of the bowl before the resection, this fatality might have been avoided. Of the two patients in whom a modified Mikulicz procedure was done, one survived and one died. The successful case had a simultaneous cæcostomy, in spite of which there were endless complications, a hospitalization of ninety-nine days and final discharge with a fæcal fistula. The fatal case was a desperate one of involvement of the stomach, jejunum and sigmoid in primary carcinoma of the transverse colon, four simultaneous resections were made with suture anastomoses in three and a Mikulicz procedure on the colon, the operation was done in an infected field owing to the presence of a fæcal fistula and death was due to peritonitis apparently from this cause. No operative method could have availed in this case. This small group of transverse-colon cases furnishes little evidence in favor of the Mikulicz type of procedure but suggests that the best available method is to make a preliminary cæcostomy and a subsequent resection with end-to-end suture, although it is likely that the cæcostomy is of little importance unless obstruction exists.

It is in the group of resections of the distal colon, from, and including, the splenic flexure to the third sacral segment, that the proper selection of various operative methods is most difficult and important. There were fifty-three resections of the distal colon for carcinoma, with forty-five recoveries and eight deaths—a mortality of 15 per cent. In eleven of these patients, the lesion was too low to permit of any form of anastomosis and a permanent colostomy was made, with one death, giving a mortality of 9 per cent. In twenty-six instances an immediate end-to-end suture anastomosis was made with twenty-two recoveries and four deaths—a mortality of 15.3 per cent. In sixteen instances a modified Mikulicz procedure was carried out, with thirteen recoveries and three deaths—a mortality of 18.7 per cent. The circumstances attending the fatalities may be compared as follows:

#### MIKULICZ PROCEDURES

CASE S 23519—Resection descending colon, hypertension, myocarditis, chronic nephritis, hepatic metastases, death in one hour from shock.

CASE S 32850—Resection of splenic flexure, death in three days, apparently cardiac.

CASE S 31188—Resection of sigmoid, death in four days from peritonitis due to leak at site of Mikulicz operation.

#### DIRECT SUTURE ANASTOMOSIS

CASE S 16555—Resection of splenic flexure, metastases in liver, death from peritonitis from defective cæcostomy, made simultaneously.

CASE S 24993—Resection of descending colon with simultaneous transverse colostomy, death in three and one-half months from myocarditis and pneumonia.

CASE S 26063—Preliminary cæcostomy, resection sigmoid, death in seven days from leak at anastomosis.

CASE S 10530—Resection sigmoid, simultaneous cæcostomy, death in five days from ileus and local peritonitis.

An interesting inquiry is as to the comparative length of hospitalization of patients operated on by the suture anastomosis and Mikulicz methods, and their condition on discharge. The twenty-two successful resections of

the distal colon made by suture anastomosis remained in the hospital an average of 43·3 days, the thirteen successful Mikulicz cases stayed an average of fifty-three days. Among the suture-anastomosis cases 50 per cent were completely healed on discharge and 27·2 per cent had a fæcal fistula, (the remainder had granulating wounds or sinuses), whereas among the Mikulicz cases only 30·7 per cent were completely healed on discharge and 53·8 per cent had a fæcal fistula. As giving some evidence of the comparative general character of these groups, it may be added that 63·6 per cent of the suture-anastomosis patients were completely obstructed on admission, contrasted with 46·1 per cent of the Mikulicz cases. If the distal colon and transverse-colon cases were combined, constituting a larger group where both the suture-anastomosis or Mikulicz procedure are applicable, the evidence appears to be even more in favor of the former. The average hospitalization of the suture group is forty days, that of the Mikulicz series is fifty-six days, the incidence of fæcal fistula is 20 per cent for the suture cases and 57·1 per cent for the Mikulicz, the mortality is 14·2 per cent compared with 22·2 per cent. In further comparison of these two methods the reviewer of the hospital records cannot fail to be struck by the frequent mention among the Mikulicz cases of pain occasioned by the application of clamps, the necessity of re-application of clamps, and the annoying infection of the wounds. In some confirmation of the general impression of the fallacy of statistics it may be mentioned that in the early days of the hospital four resections were done by the original Mikulicz method with good recoveries and average final results.

A question which has been of especial interest to the writer for some years is that of the relative efficacy of a cæcostomy or colostomy of temporary type made with a tube which necessarily diverts only a part of the fæcal current and acts as a safety-valve to prevent gaseous distention, and a proximal colostomy of permanent type which completely diverts the bowel contents. In theory, the former is easier to make, gives sufficient escape of the fæcal current to safeguard the anastomosis and will close spontaneously, while the latter is harder to make, is unnecessarily complete in its function and always requires formal operative closure. The writer believes that all but the last of these assertions are frequently untrue, and that the permanent type colostomy as a preliminary to all resections with suture-anastomosis of tumors of the colon distal to the mid-point of the transverse colon is the operation of choice. In this viewpoint he is probably greatly in the minority since most surgeons perform the temporary cæcostomy or colostomy as a matter of course. Pfeiffer and Smyth,<sup>15</sup> however, and Judd<sup>2</sup> advocate complete diversion of the fæcal stream and irrigation of the distal colon to cleanse it before resection, and Gordon-Taylor<sup>5</sup> has already been quoted as doing a complete cæcostomy. Rankin<sup>7</sup> states that operative closure of a colostomy is a much more formidable procedure than of a cæcostomy. For some years the writer has practised the permanent type colostomy in suitable cases as

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a preliminary drainage operation and has found it both satisfactory in its immediate results and not difficult to close

The experience of the Peter Bent Brigham Hospital throws a good deal of light on this question. Among thirty successful resections of the colon distal to the hepatic flexure, with suture-anastomosis, there were nine preliminary and one simultaneous cæcostomies. Of these patients no less than four had a fæcal leak at the anastomosis and two required operative closure of the cæcostomy. There were four instances of colostomy of temporary type (not diverting the entire fæcal stream), of which no less than three had gross fæcal leaks at the point of anastomosis, one had local infection and three had to have secondary operative closure of the colostomy. One of these supposedly temporary type colostomies became a permanent fæcal fistula which the patient would not return to have closed. In other words among these fourteen patients, in 50 per cent there was failure on the part of the safety-valve to prevent fæcal leakage at the anastomosis and in 42.8 per cent it was necessary to make operative closure of a stoma which is supposed to heal spontaneously. On the other hand, there were eight instances of preliminary colostomy of permanent type, completely diverting the fæcal stream, of which none had fæcal leaks at the anastomosis, and three had slight local infection. In closure of these colostomies three healed per primam and only one had a slight fæcal leak, which does not seem to bear out Rankin's statement as to difficulty of closure. There were no deaths where resection was preceded by this type of stoma. So far as proof can be afforded by a limited number of cases, it seems very evident that a permanent-type colostomy, completely diverting the fæcal stream, is vastly superior to one of temporary type in accomplishing the object for which this preliminary operation is done. Incidentally, the surprising fact also appears that among these thirty successful resections with suture-anastomosis in the distal colon there were eight in which no preliminary or simultaneous safety-valve operation of any sort was done, yet none had any gross fæcal leak although two had complete obstruction on admission, and five had no infection of the operative wound. There was no mortality in this group. This again illustrates how misleading statistics may be, for certainly no surgeon of experience would advise as a routine, primary resection with suture-anastomosis in the distal colon without making a proximal safety-valve.

The method of suture-anastomosis adopted in the great majority of these cases was the most simple sort of open suture, consisting of an over-and-over stitch embracing all layers, supported by a continuous sero-serous stitch and with disposal of the omentum about the suture line. In no case has any special instrument or device been used, and in only a few instances has any aseptic method such as that of Kerr been employed. In the closure of the permanent-type colostomy the bowel is carefully dissected free from skin, areolar tissue, aponeurosis, muscle and the edge of the peritoneum, but the free peritoneal cavity is not entered. If but a small opening was made originally in the bowel the mucosa will be found much everted. If now the

delicate white linear cicatrix which has formed at the edge of the incision in the bowel wall and which now tends to constrict and maintain it in eversion is carefully dissected off, the mucosa can be readily turned in and a surprisingly small opening remains to be closed by a two-layer catgut suture. A folded bit of protective tissue should be carried down just through the aponeurosis, and the wound otherwise closed in layers.

The scrutiny of this group of cases of resection of the colon for carcinoma has gone far toward confirming opinions which have gradually crystallized in the writer's mind and which for some years he has been adopting in practice. The particular doctrine which he wishes to support and which seems to him to be justified by the experience quoted above, is that a colostomy of permanent type, made as a preliminary or first-stage operation in resection of the distal colon, and later closed when its work is accomplished, is much superior to the tube-drainage, temporary type of procedure. Its advantages are that it completely diverts the fecal contents, which gives the best possible relief of obstruction, it permits the cleansing by irrigation of the operative field in the distal colon so that something akin to an aseptic resection and anastomosis may be done—whether by open suture or by some special technique—it absolutely prevents any strain on the suture line by distention by gas and fecal matter, and any soiling from the same source. Its disadvantages may be alleged to be greater difficulty in execution, and the necessity of formal closure. As a matter of fact, it is no more difficult to make a permanent than a temporary type of colostomy, it occasions less wound infection, and as already pointed out its closure—for which no anæsthesia except local infiltration is necessary, is not difficult. There is no reason why in favorable cases the colon at the seat of the proposed resection may not be rendered practically aseptic. If the lesion has caused obstruction and much fecal material has accumulated proximal to it, but distal to the colostomy, difficulty may be experienced in clearing it out, but usually with the rest afforded by the colostomy and the consequent subsidence of œdema and inflammation the passage of the bowel contents, softened by appropriate means, can be secured, and in any event if it remains in the colon it will not threaten the anastomosis until healing is complete and the colostomy closed.

An attempt may be made to formulate a plan for the selection of the appropriate operation for carcinoma of the colon, on the basis of the experience above recounted, as follows: in a lesion of the right colon from the ileo-cæcal valve to a point beyond the hepatic flexure, the entire right colon should be removed and a suture anastomosis made between the end of the ileum and the side of the colon, a provisional proximal jejunostomy may be made by the Witzel method, but is probably unnecessary. In carcinoma of the transverse colon, a cæcostomy should be made, using a large-calibre rubber tube, followed after its function is well established, by resection of the lesion and end-to-end anastomosis by any recognized method of suture. Probably the cecostomy may be omitted with slight risk. In lesions of the

distal colon including the splenic flexure, a permanent-type colostomy should first be made in the transverse colon, through either the right or left rectus, but preferably the former, and after obstruction has been relieved the function established and the distal bowel rendered as aseptic as possible, a resection of the lesion with end-to-end anastomosis by the suture method should be done. The colostomy may be closed under novocaine anaesthesia after eight or ten days. If the carcinoma is situated far distal in the sigmoid, anastomosis may be impossible, in which case after resection, if the proximal end cannot be brought down to the anus, the distal end is closed and dropped back and the open end of the upper segment brought out as a permanent anus. If the lesion is still more distal it will come in the category of a rectal carcinoma and will presumably require complete abdomino-perineal extirpation. If the patient is admitted with complete obstruction and it is impossible to determine the site of the lesion, it is the writer's practice to make a transverse colostomy through the right rectus under novocaine, on the theory that in the great majority of cases colonic carcinoma will be found distal to that point, and that a proximal lesion is not likely to cause obstruction. If the transverse colon is found collapsed at that point, it is wise to enlarge the incision and explore, since the lesion is likely not to be in the colon at all but to be in the small intestine and to require immediate radical treatment. If after the obstruction is relieved a barium enema and other diagnostic measures reveal a distal lesion which is inoperable and which is best relieved by a sigmoidostomy, no chagrin need be felt at the failure to provide this at first, since the exploration and sigmoidostomy will be performed much more safely as a second stage. Finally, operative campaigns based on the Mikulicz procedure seem to the writer to be inferior to the plan above outlined on the score of mortality rate, length of hospitalization, comfort of the patient and incidence of complications. They should be reserved for certain special conditions and emergencies where they are obviously indicated.

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# INTESTINAL OBSTRUCTION FROM CARCINOMA OF COLON

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THE highest death-rate in intestinal obstruction from all causes is from carcinoma of the colon. It is between 40 and 50 per cent. Souttar reported that in seven London hospitals during 1920-1924, the mortality rate was 43.5 per cent, and only exceeded by that of intestinal obstruction due to gall-stones which was 50 per cent. Obstruction is the ultimate symptom of a large majority of cases of cancer of the colon. Carcinoma is often silent until it is considerably advanced and obstruction may be the inaugural symptom. Carcinoma generally kills by obstruction. Burgess found that 35.6 per cent of his cases came to the hospital with complete obstruction. With symptoms of acute obstruction, when obvious causes like hernia can be ruled out, one can suspect the colon in elderly people as being the cause. If it is in the colon, 90 per cent are due to carcinoma. Practically all lower left-sided lesions have some degree of obstruction, and as regrettable as it is, obstruction is the most significant single diagnostic manifestation.

Complete intestinal obstruction should be said to exist when obstipation for a period of two or three days with pain, vomiting and distention persists after two turpentine clysta. There may be one or two stools from enemata below the block, but after that no faeces or flatus escapes and the colicky pain is undiminished. The picture is not as clear cut or absolute as obstruction of the small intestine by adhesive bands or strangulation. There is not so much shock or vomiting, there is not the fatal loss of chlorides and there is also the absence of the dangers of circulatory constriction resulting in gangrene. Obstruction of the colon is none the less deadly.

Visible peristalsis should be sought for and any reasonable time spent in looking for this important sign is well worth while. It is relatively early and may be obliterated later by distention and paresis. Vomiting is late in appearing. The lower the obstruction, as is well known, the less the vomiting and contrariwise. Vomiting occurs in about one-half of the cases. Pain is not so compelling in colonic obstruction as in ileus, but should not be silenced with morphine until it has told its tale. It is characteristically below the umbilicus in colon obstruction, save in the ileocaecal zone. Pain was the chief symptom in sixty-five of 102 cases without obstruction (Morrison). Catharsis, while not so murderous in blockage of the large gut, is nevertheless well-nigh brutal. It intensifies the pain and may precipitate perforation.

The near aphorism that epigastric distress is more prone to originate in the caecum and right half of the colon than it is the stomach, should at least arouse our suspicion.



The symptoms of carcinoma are notoriously inconspicuous Prior to the onset of obstructive phenomena bearing on the diagnosis there are some points in the history that if present are significant The most important is change of intestinal habit lasting from a week to a month Among the others are abdominal distress, dyspepsia, occult blood, weakness and anæmia, urgency with futile attempts, palpable tumor in the right side, loss of weight and strength, constipation, blood and mucus When low down in the rectosigmoid area, the partial obstruction may cause the classical compensatory diarrhoea The duration of carcinomatous growth before recognizable in men is 7-8 months, in women 8-9 months (Morrison)

When there is any type of intestinal dysfunction, such common and all-pervading symptoms as constipation and diarrhoea are probably dismissed with less careful inquiry and investigation than any other one presenting symptom

Prior to obstruction, progressive constipation exists in from one-fourth to one-half of the patients in the presence of a low left-sided lesion

The question may well be asked how long should constipation be treated symptomatically without an examination and without thought of its mechanical cause? Moynihan says "In left colonic growths, constipation is the rule, while in right colonic growths constipation is rare"

*Chronic intestinal obstruction* probably exists in a greater or less degree in 40 per cent of the cases, when seen by the surgeon When not well marked, it can only be inferred by the intestinal distention with cramps and irregularity of bowel movement Sometimes the patient has a definite sensation of stoppage of the faecal flow at a certain point which he will indicate Moreover, the gurgling of gases through the stenosed area is audible and should be listened for

Cases diagnosed rather cavalierly as "intestinal indigestion" on account of bloating and mild distress, often mean carcinoma Chronic appendicitis, a diagnosis which always requires support and creates suspicion, may, in an elderly person, be a masquerade for carcinoma Medical treatment is a positive disadvantage because restricted diet and mineral oil unfortunately obviate the pain that a generous diet and a lack of solubility of stools would produce, which would necessitate a more careful investigation Partial obstruction associated with abdominal cramps and urgency of bowel movement, perhaps with diarrhoea, is sometimes associated with streaking of the stool with blood This would be the colloid, adeno-carcinoma, with ulceration and resulting fixation and tumefaction Partial obstruction over several days temporarily relieved by enemata, may recur after days or weeks and sometimes months of relative freedom, only to reappear with redoubled vigor or with complete obstruction

Visible peristalsis is not as appreciable in the large intestine as it is in the small and can be, of course, seen more easily in thin subjects and when seen is of a sluggish undulation more prolonged In the low, recurring type of partial obstruction, not due to annular constriction, the patient may bear

## INTESTINAL OBSTRUCTION FROM COLON CANCER

the complete obstruction with comparatively few symptoms except increased, persistent, and continuous distention of the abdomen

One thinks of the stomach as being the most frequent site of carcinoma. The large intestine, including the rectum taken as a system, produces more carcinomata than the stomach itself. Approximately half are in the rectum and the other half in the colon. Of those in the colon 50 per cent are in the sigmoid, nearly a third in the ascending and transverse and the smallest number at the flexures which are the fixed portions. The large intestine down as far as the splenic flexure develops from the primitive mid-gut with the flexibility and absorptive properties of the small intestine. Hence large growths can exist in the right half of the colon for long periods without obstruction. The descending portion develops from the primitive mid-gut. Here absorption is near completion, the excreta is dehydrated and more solid and the function of the left half of the large intestine is largely storage. Practically speaking, it may be said that tumors from the cæcal region to the splenic flexure are associated with diarrhoea and severe anæmia. Whereas those below the splenic flexure are associated more with constipation and without anæmia.

The large, flat, fungating, soft encephaloid types of tumors in the cæcum and ascending colon rarely ever produce obstruction. Whereas the stenosing, fibrotic type or so-called napkin-ring carcinoma on the left side of the colon is very prone to produce gradual constriction of the lumen with increasing although undetected symptoms of partial obstruction until it finally becomes complete. The large tumor at the head of the cæcum is sometimes felt by the patient himself and is a fortuitous circumstance. Such a patient of ours who had no other abdominal symptom whatever resulted in a five-year cure so far. A mass that is palpable is not a sign of inoperability any more than it is in carcinoma of the stomach. There is often a spool-like lesion with no lymphatic involvement. With symptoms frankly suggestive of obstruction, Roentgen-ray as a rule is not required. Valuable time should not be lost. If convenient, and the condition of the patient will permit, a barium enema may be given and a plate quickly made.

The redundancy of the sigmoid and it being sequestered in the bony pelvis, sometimes offer difficulties whereby the filling defect in the narrow canal, surrounded by the growth, may be entirely obscured by an overlying loop of sigmoid. This taxes the skill of the roentgenologist, but with care, experience, manipulation and palpation, this can be obviated. The skilful employment of the fluoroscope is more revealing than the plates.

A barium enema is much preferable to the barium meal from above which may be a menace in chronic obstruction because in a partial obstruction the lumen may become quite closed and plugged by a mass of barium.

A bimanual rectal examination may sometimes be rewarded by the location of a low-lying growth and should be routinely and searchingly made.

I once reported a group of five cases of complete intestinal obstruction from carcinoma of the rectosigmoid and rectum which had not been previ-

ously diagnosed or even examined by digital method. Failure to examine the rectum not only for suspicious symptoms but in a routine physical examination is one of the scandals of our diagnostic errors. Low-lying growths can be visualized by the sigmoidoscope and if possible a biopsy may be made to determine the grade of cancer and its bearing upon advice and prognosis. Surgeons may not need the admonition to use extreme gentleness. Gray Turner refers to five cases in his knowledge of perforation of the sigmoid by the sigmoidoscope, one in his own hands resulting fatally although immediate abdominal section and suture were carried out. In unlocalized obstruction the blind cæcostomy, under local anaesthesia without exploration, is the procedure of choice.

Obstruction occurs six times as often on the left half of the colon, in the experience of Burgess, as it does in the right half—87 per cent versus 13 per cent. A simple colostomy, however, is a serious undertaking as in the Brigham Hospital series the mortality was 39.1 per cent and Gray Turner's was 39 per cent. Resections in both of these clinics were about 19 per cent only. With preliminary colostomy it was 9½ per cent and without it was 35½ per cent.

The permeability of the diseased gut, with the trauma of the handling, invites an exudate of virulent microorganisms. This largely explains the higher death-rate of palliative colostomy. The amount of manipulation required to determine its obstructiveness and the future operability is ill-timed. It sets free the highly septic flora of the obstructed growth and sets up a degree of peritonitis that in aged, debilitated, dehydrated patients is so often fatal. It is the toxicity of the imprisoned secretions above the obstruction that gives the added danger to exploration. Thus in a small number of acute obstructions at the Mayo Clinic, the mortality for colostomy was 42.85 per cent, whereas palliative colostomy, on account of inoperability, gave a mortality of 7.67 per cent and colostomy in the group where further operation was considered advisable was only 2.7 per cent. Generally speaking the "blind cæcostomy" proposed by Stiles in the acutely ill and completely obstructed patient is wise and safer surgery. The Gibson type of cæcostomy with a three-quarter-inch tube is satisfactory.

With spinal analgesia and a moderate Trendelenburg position, in not too obese subjects, the parietal wall can often be elevated and mobilized sufficiently to visualize the lesion without the danger of unwarranted and dangerous exploration to determine the location.

If any exploration at all is done, the general abdominal examination, liver, *etc.*, should be alone carried out. In any event it should precede even the most superficial examination of the growth. Everyone can recall instances where only an exploration to determine the site and character of the lesion would have prevented disaster. Therefore spinal analgesia, and its amazing relaxation, allowing visualization, is a most helpful substitute for manipulation.

In partial obstruction, where the growth is inoperable, short-circuiting is in some instances preferable to colostomy. It will overcome the future attacks of painful near-obstruction and is preferred always by the patient to colostomy. Partial obstruction, where not too severe, can sometimes be well treated by anastomosis, say between the transverse and pelvic colon without resection. Rowlands reports a successful subsequent removal of a resultantly shrunken growth in the splenic colon in these circumstances. Splenic growths are obstructive in 100 per cent. Where no secondary removal is possible internal anastomosis is in some instances more desirable, even though bought at a slightly greater hazard. The mortality of colo-colostomy or ileocolostomy is approximately 30 per cent.

Colostomy of the modified madyl type with a muscle split incision low down on the left side in front of the anterior superior spine is perhaps the simplest.

Rankin suggests returning the excess of the distal colon back into the incision and pulling up on the proximal until a fixed portion is reached near the junction, obliteration of the opening to the outer side of the colon by a purse-string suture to the lateral fold of the peritoneum, sewing it to the parietal layer to prevent the foramen being left patulous, suture of the peritoneum and also the abdominal skin under the protruding arch of the sigmoid, suture of the fascia loosely, and lastly the avoidance of handling the growth as peritonitis causes half of the deaths.

Resections at the Brigham is 19.2 per cent, which closely parallels the result of Gray Turner's—19 per cent operative mortality.

Resection with preliminary colostomy gave 9.6 per cent, whereas resection without preliminary colostomy 25.5 per cent. Preliminary colostomy is not so applicable to colonic growths, but it can be profitably done in two stages. One can proceed to resect even in the presence of liver metastasis. The risk is not much greater and life was prolonged on an average of seventeen and one-half months. "A resection is often the best palliation," says Gray Turner.

The Mikulicz-Paul operation in the movable part of the colon, may be employed in partial obstruction with satisfaction. The obstructive resection obviates possibility of cancer implant in the wound.

Bolling reported thirty-three cases of Mikulicz' operation at St. Luke's with two deaths. Cheever reports 16.1 per cent mortality for resections with complete obstruction and 21 per cent mortality without complete obstruction, which means that the cases with complete obstruction probably had, of necessity, preliminary colostomy. "Obstruction may be regarded as actually a favorable complication" (Cheever).

# SURGERY OF THE LARGE INTESTINE

By WILLIAM J MAYO, M D

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I HAVE been asked by the officers of the American Surgical Association to present a paper on surgery of the large intestine, based on the records of the Mayo Clinic from the first radical operation, in 1890, to January 1 1931. In this period, 5,426 operations were performed on the cæcum and ascending colon, transverse colon, sigmoid, and rectosigmoid, and 3,312 on the rectum. In reviewing this mass of data representing forty-one years of a developing field of surgery, one finds much of interest but also much which would take up time unprofitably.

In an endeavor to deal with so large a mass of statistics of operations performed by several surgeons over a long period, it is difficult to do more than to state generalities, and these generalities should not be granted such weight as the number of cases reported might indicate, lest significance be attached to quantity rather than to quality. It should be remembered that reports of smaller groupings of statistics presented by surgeons who have worked up their cases in great detail from every standpoint might in many respects have greater significance than composite statistics such as I might present.

The statistics given in detail in the accompanying charts, for which I am indebted to Dr. Fred W. Rankin, are for the years 1929 and 1930. For the earlier years from 1890 to 1929, I shall content myself with brief historic comments on the growth of our knowledge in this field.

First I should like to direct attention to some of the physiologic and anatomic facts which have been developed in this period largely through clinical investigation and research. The significant fact to be deduced is the gradual change from surgery controlled by gross pathology to surgery based on physiology. It should be noted that the understanding of early processes which lead to the late manifestations of disease which controlled surgery in the past is helping us to a broader comprehension of disease in its earlier stages and consequently an increased percentage of cures. In this better knowledge the Roentgen-rays and various forms of endoscopic examination are playing a remarkable part.

*Physiologic and Anatomic Considerations*—In any consideration of an organ we always think of anatomy as fundamental, but in reality physiology is the architect which designs the anatomic structure.

Embryologically, the colon has its origin on the left side of the body, and the small intestine in six primary convolutions on the right side. At about the eleventh week the embryonic colon begins to move to the right, and continues to move until the head of the colon reaches its normal situation soon after birth. The right half of the colon originates with the small intestine

from the mid-gut, having in the embryo the same villi, and it retains the same blood supply from the superior mesenteric vessels as the small intestine. Comparative anatomy indicates that a small proximal colon is characteristic of the carnivora, and unabsorbed end-products of protein metabolism undergo putrefaction, whereas in the herbivora the huge proximal head of the colon with its silo-like capacity is for the purpose of extracting carbohydrates from the herbivorous diet, the unabsorbed end-products undergoing fermentation. In man we see in the moderate size of the cæcum and ascending colon a characteristic feature of the omnivora, its purpose is to remove nutritive material from protein, fats and carbohydrates, the unabsorbed end-products of which undergo both putrefaction and fermentation, and in these processes lies the possibility of development of toxic products, the absorption of which may be the cause of certain disorders. We see manifestation of this possibility of toxicity in the anæmia which so often is evident in connection with tumors of the proximal half of the large intestine. Often œdema of the lower extremities is present, with other signs and symptoms which fortunately do not have the same prognostic significance as similar conditions in other parts of the body, since many of these debilitated patients are to be cured by radical surgical procedures.

Recent investigations by Alvarez and his colleagues have shown the influence of food products on mass. Among the various types of food which form a mass, such common articles of diet as potatoes and milk form relatively large masses, whereas red meats induce a large amount of bacterial action. Three-fourths of the peoples of the world eat rice for carbohydrate, and more or less fish for protein. Rice not only has a high-calorie content but also liquefies and forms only a very small mass, such articles of diet as fish also form a small mass. It would be interesting to know whether diverticulum of the large intestine is as common in the countries in which rice and fish are eaten as it is in the countries in which potatoes and red meats are eaten.

The left half of the large intestine, like the stomach and the urinary bladder, has a reservoir function. The absorptive power of this portion of the bowel is not great, and its peristalsis is largely reverse except during defecation, to move the products back into the absorptive part of the large intestine where fluids and nutritive materials may be taken up. We often speak of rectal alimentation, when we simply mean that certain materials are passed into the rectum for reverse peristalsis into the right half of the colon to take place, as food is taken through the pharynx and the œsophagus into the stomach.

Man has little consciousness of what is going on in the small intestine and right half of the colon, whereas he is more or less conscious of the action of the sigmoid.

In mammals the testis is the primitive procreative organ, and because of its long heredity it is relatively free from disease, the ovary, secondary to the testis, is a more recent acquisition which has not yet achieved the same resistance. So, too, the colon, of relatively recent development, has not yet achieved the stability of the primitive small intestine.

The autonomic nervous system is largely independent of the central nervous system. The autonomic fibres regulate the action of the gastrointestinal tract, and the other viscera, the ductless glands, the blood-vessels, and all organs containing involuntary muscle.

The autonomic nervous system has for one of the most important tissues under its control the non-striated muscle, which was probably the oldest of all forms of control. Then came the internal secretions followed by the sympathetic nervous system, the internal secretions might be said picturesquely to play on the sympathetic nervous system to produce its results as hands and fingers play on the piano. This association with the non-striated muscle is well shown in the intramural plexuses of the gastrointestinal tract, as described by Keith, and again by intestinal peristalsis, several contractions to the minute, and that vascular type of peristalsis which occurs eighteen to twenty times a minute and acts as the heart of the portal circulation to the liver.

Gaskell described the small, round, medullated nerves which connect the anterior horns of the spinal column with the great sympathetic nodes, all of which are direct connections, except those which pass to and through the suprarenal glands before reaching the ganglions, showing the close connection between the important internal secretion of the suprarenal glands and the sympathetic system. Langley described the parasympathetic nerves, the vagus and pelvic nerve.

We begin to see that certain obscure happenings in connection with the large intestine may be due to localized spasms of the smooth muscle layer of the blood-vessels. Again, now that we are getting new light on the sympathetic nervous system, which acts as a brake on intestinal peristalsis, we see a possible explanation of some phases of the development of diverticulosis. Learmonth and Markowitz have shown that after section of the inhibitory nerves to the colon of the dog, a barium meal may produce an appearance suggestive of early diverticulosis.

The work of Hunter and Royle has stimulated fresh surgical interest in the sympathetic nervous system. In this field Adson, Rowntree, and their associates have been able to relieve megacolon and similar disorders which resemble the dilated œsophagus in cardiospasm, by removal of the lumbar sympathetic ganglions and their communicating branches. The operation effects its purpose probably by leaving the sacral sympathetic outflow, which is motor to the distal part of the colon, in sole control of this part of the bowel. Such procedures have also brought about marvelous relief in Raynaud's disease, in disease of the blood-vessels of the extremities, in which one element is contraction, leading to gangrene, such as is seen in Buerger's disease, and in certain types of chronic arthritis, by removal of appropriate sympathetic ganglions and their communicating branches.

In 1909, I presented before this Association the results of some anatomic investigations which developed the fact that the external peritoneal attachments of the colon on the right side did not contain blood-vessels or other structures of importance and that these attachments to the lateral abdominal

wall could be readily divided, so that the colon could be freed on the right side and to a considerable extent on the left side, and drawn out of the abdomen for careful dissection under the eye. By this means the lymph-nodes were made accessible and the relations of the blood-vessels, especially the right colic and ileocolic arteries, were made clear. But that part of the colon to which the omentum was attached did not permit of this manoeuvre to the same extent, especially in the high-lying splenic angle which acts mechanically to hold fluids and food in the absorbing right half of the colon.

In 1917, I presented a paper before this Association on the anatomy and surgical relationship of the rectosigmoid. The region of the rectosigmoid is of great interest, it is the most constricted portion of the large intestine, and it is here that the type of epithelium changes. The upper valve of Houston, situated immediately below the rectosigmoid, suggests that this portion of the bowel has mechanical function, and one sees why it is so frequently affected by malignant disease.

#### SURGICAL COMMENTS

Of the thirty-one papers I have presented before this organization, six have been on the large intestine. And as I review these contributions to the subject under discussion, I find a picturesque history of the development of this interesting field of surgery. One of the outstanding contributions to this development was the adoption by C. H. Mayo, in 1896, of the two-stage operation for resection of the large intestine, to overcome the obstruction which to some extent is so often present, and later his modification and popularization of the Mikulicz operation. In this procedure the diseased portion of the colon, with its glands and other involved tissue, was brought outside the abdominal wall and fastened, and not removed until protective peritoneal adhesions had formed. The ends of the bowel formed at the colostomy were united later.

Of great worth also was the contribution of Balfour, who, in 1910, demonstrated the value, in primary resection in continuity of the sigmoid and rectosigmoid, of passing a tube, of the stomach-tube type, through the anus and rectum to a point 6 or 8 inches above the anastomosis, and leaving it in place for seven to ten days, to carry off the gas, to prevent angulation, and to maintain the intestinal channel in proper position. This procedure, in the absence of obstruction, often enables one to save function and to avoid the necessity of making a colostomy, either temporary or permanent.

*Benign Disease*—In the decade from 1890 to 1900 operation was performed in the clinic in seven cases of tuberculosis of the large intestine, in five of which resection was made with truly extraordinary results. In those earlier years we saw relatively more tuberculosis of the intestines than in later years. The hyperplastic ileocecal coil, like the old types of disease of the bones and joints, was largely the result of the bovine type of the bacillus of tuberculosis carried in milk, and as the years have brought pasteurized milk, these types are disappearing.

In 1907, Wilson, Giffin and I reported five cases in which a portion of sigmoid was excised for obstructive diverticulitis, with formation of tumor.



These were the first instances recorded in which an actual demonstration of the pathologic change in diverticulitis was made during the life of a patient. I presented a paper on diverticulosis at the last meeting of the Association (1930), and I have nothing of importance to add to the subject.

*Malignant Disease*—C. H. Mayo taught us to wrap the colon with the omentum in cases in which the blood supply was seriously injured, and also to use the omentum to protect the anastomosis in resections as far as possible, sometimes drawing the colon through an artificial opening in the omentum and attaching it to the parietal peritoneum, so that if perforation occurred at the site of union, the peritoneal cavity would be protected.

In surgery of the sigmoid the anatomic relation of the ureters in the pelvis must be taken into consideration. On the left side, especially, the ureter may be and often is so closely attached to a growth in the lower part of the sigmoid that it cannot be separated without the possibility of leaving a portion of the growth with the adherent ureter. In my first case of this character, after a difficult operation, finding an otherwise normal ureter closely attached to the involved sigmoid in a removable malignant growth, I cut and tied it at the brim of the pelvis and removed the lower part of the ureter with the growth, intending to remove the kidney at the same time. The condition of the patient did not permit such a manoeuvre, but I expected to be compelled to remove it when the patient was sufficiently recovered. I found, to my surprise, that no ill effects followed. The patient lived more than eight years in good health, and died from another cause. Since that time, on similar occasions I have not hesitated to tie and cut a normal ureter, bringing about dysfunction and atrophy, and without harm. I have no doubt that accidental cutting of a ureter happens occasionally on one side in performing hysterectomy without any one's being the wiser.

In 1917, I first performed transperitoneal sigmoidotomy for removal of a bleeding papillomatous growth, and found it very easy of accomplishment. After incising the sigmoid, the growth, which was single, was brought out of the sigmoid and the cone of normal mucous membrane at the base was ligated and cut with the cautery. The sigmoid was closed and the wound was closed without drainage. We have had a number of cases of this general description without a death, and have found the procedure much safer in every way than resection. None of the patients has had further trouble.

It frequently happens that in the course of an exploration because of carcinoma, the finding of enlarged lymph-nodes has acted to interrupt a radical operation. Unless such a node is removed and shown to be carcinomatous, the conclusion that excision is useless is not always justified. In many instances we have operated on patients who have had such explorations and have found at later operation that the nodes were not carcinomatous, and radical operation was performed successfully.

There are some exceptions to the inadvisability of radical operation for incurable carcinoma, the chief of which is removal of an operable primary growth when secondary growths are present in certain situations—for instance, in the liver. The liver has the greatest power of regeneration of

## SURGERY OF THE LARGE INTESTINE

any organ in the human body. In three operations several months apart the entire liver of a dog can be removed, as shown experimentally by Mann, with eventual complete regeneration. When carcinomas of the stomach, rectum, or large intestine are safely removable locally, it is sometimes advisable to excise the primary growths as a means of palliation and to prolong life, thus enabling painless secondary processes to bring about the fatal issue rather than the original processes to result in painful death. Metastatic processes in the liver have room for enlargement without infection or pressure on neighboring organs, nerves, and tissues, and the patient may live for many months comfortably and then die painlessly. It has been pointed out by specialists in tuberculosis that if the primary lesion can be removed or cured, the secondary lesions are more readily cured or delayed in growth than is the primary lesion. This may also be true to some extent of malignant disease.

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DISCUSSION.—DR. J. SHELTON HORSLEY (Richmond, Virginia) said this has been an extremely interesting group of papers. He said Doctor Cheever has shown very clearly in his statistics the indication for an enterostomy before resection of the colon. He believed that the enterostomy should be complete, using the old operation, bringing the bowel onto the abdominal wall and putting a glass rod under it. This is done through an extended McBurney incision, mobilizing the cæcum and ascending colon if necessary in order to bring it to the abdominal wall.

Ten days after the enterostomy the resection may be done, and the bowel will be found contracted, containing no fecal matter, and having comparatively few bacteria.

Ten days after the resection the enterostomy is closed. This closure of the enterostomy is readily done, though it may appear at first to be difficult. After withdrawing the glass rod, the everted mucosa is turned into the lumen of the bowel by manipulating it, using petrolatum, and is held in the bowel by a few stitches of fine

tanned catgut One or two other rows of interrupted sutures of the same material are placed and the ends are left long These sutures are sometimes under tension, and under ordinary conditions would appear to be unsafe The peritoneal cavity is then opened and the adhesions to the affected loop are separated and the bowel is dropped into the peritoneal cavity The long ends of the suture are threaded in a needle and passed through the parietal peritoneum just above the wound The wound is then closed loosely in layers with catgut, drainage being placed down to the peritoneum Here sutures approximate the bowel snugly to the parietal peritoneum If there is fecal leakage it does not occur for at least several days, and in the meantime the general peritoneal cavity has been thoroughly protected by adhesion to the parietal peritoneum There is almost always some suppuration, but usually no fecal matter appears In ten days after the resection has been done the union at the site of resection has probably become firm

In one type of case, in which the patient is fat or the tumor is large or adherent, end-to-end or even lateral anastomosis is probably inadvisable Here the Mickulicz type of procedure is doubtless best The bowel is mobilized, the mesentery is severed and tied as though the resection were to be done immediately, and then the affected loop is brought onto the abdominal wound Two rows of sutures appose the portion of the bowel where the spur is to be, taking care to bring together the walls of the bowel which contain no large vessels Drainage of gauze and tubes is placed into the peritoneal cavity, reaching to the stump of the severed mesentery The loops in the bowel are doubly clamped and divided with the electric cautery The clamps on the stumps are left on for at least several days, the drainage is removed in two or three days The spur is opened by applying a soft-bladed clamp such as is used for occluding the bowel during intestinal anastomosis, clamping this gently, so that only the tips at first become engaged, and then after twenty-four hours the clamp can be more firmly applied and the bowel will not slip from its grasp

As illustrations of these two types of operations, Doctor Horsley reported these two cases

Mrs L H, aged seventy-three years, was quite fat and in rather poor physical condition The left half of the transverse colon had a large necrotic carcinomatous ulcer with some adhesions and a few large lymph-nodes The type of Mickulicz operation that has been mentioned was done, and the patient made a satisfactory recovery

A patient representing the type of end-to-end suture that has been described was Mrs A M B, aged eighty-four years There was an annular carcinoma of the sigmoid A complete enterostomy with a glass tube was done on the right side, and ten days later a resection was done with end-to-end union as described There were a few involved lymph-nodes in the mesentery attached to the resected portion of the bowel Ten days after the resection, the enterostomy was closed After closing the enterostomy there was rather marked bronchitis, which, for a while, seemed ominous, but she recovered from this in a few days and made a satisfactory convalescence There was never any trouble about the abdominal healing

Doctor Horsley felt that in every case, whatever the technic of resection is, whether there is an obstruction or not, it is important to do an enterostomy at least ten days before and to do it in such a manner that one can tie it off, and, at the same time, so that it can be easily closed later on

DR LEONARD FREEMAN (Denver, Colo) said the old controversy that has gone on for so many years as to which is the better method of uniting the large bowel after a resection, as to whether it should be done end-to-end, or side-to-side, has been decided, in this country at least, pretty well in favor of the end-to-end anastomosis, in spite of the fact that the side-to-side anastomosis offers a much better field for work in the peritoneum and the blood supply is better

He did not believe this to be properly decided Quite recently Fnnistere, in Vienna, has suggested a method by which the side-to-side anastomosis can be done with a great deal of safety He has used a method for a number of years, and has had opportunity

## SURGERY OF THE LARGE INTESTINE

in some instances to examine a case after death, and sometimes even before death. He has found results to be satisfactory.

The principal objection, of course, to a side-to-side anastomosis is the dilatation of the free end of the colon. He did not believe that that is necessary to occur, it can be avoided in a very simple way. In the first place, by making the anastomotic opening quite large, and in the second place, by making the end of the dividing cut short, so that it comes up as close to the opening as it can without obstructing the opening, and in the third place (and the most important thing), using chromic sutures to unite the free end of the bowel to the adjacent bowel—in this manner one easily avoids dilatation.

DR EMMET RIXFORD (San Francisco) said that he had had the experience of uncovering the colon, seeing it full of obstruction or carcinoma, and as soon as the pressure, or the support of the abdominal wall was released, the peritoneum split, showing the force of the gases within the colon.

Another case of a similar sort was a woman who had been shot in the region of the spleen and developed an obstruction. The operator cut down and relieved the obstruction—at least he thought he did—but being a very conscientious man and bound to have the bowels move afterward, he gave the patient pituitrin. Such a degree of peristalsis was started up by the pituitrin that the small bowel contents were forced into the cæcum to such an extent that it burst as soon as the support of the abdominal wall was relieved. So Doctor Rixford said he was afraid of pituitrin in obstructive conditions.

In regard to Doctor Freeman's point about the dilatation of the end of the gut in a lateral anastomosis. Doctor Rixford had done a good many of them and had had no particular trouble from that source. But he would warn against making the end too short. He had one disaster just because of that. The circulation in the end of the gut had been interfered with by the operative procedure and perforation occurred.

Another point in the use of the Mikulicz method. He had the misfortune to take care of a man suffering from carcinoma of the sigmoid. It was in the early days of the Mikulicz procedure. Everything went well until they came to the point of closing the colostomy. They used the Mikulicz apparatus. After two days, perforation occurred in the peritoneum. Why? Because the superior hemorrhoidal artery was crushed by the forceps and obstructed, and a segment of the gut below died.

DR FRED B. LUND remarked that he thought it to be a little safer. He had had recurrences in the abdominal wall follow, but he did not think that to be worth consideration in the case under discussion. Of course, in cases of diverticulitis, one does not have to think about recurrence. It is only in carcinoma cases that one considers it.

The method of resection which Doctor Rankin brought out does away with a great deal of the danger of the Mikulicz procedure in a good many cases.

Doctor Lund has never had any dangerous cutting through of the vessels by the clamp. Sometimes the clamp stays longer than one wants it to, and sometimes it comes off sooner than one wants it to—sometimes one does not get enough of a partition the first time—but it is the safest method in a most desperate set of cases.

DR W. E. SISTRUNK added, in defense of the Mikulicz operation, that this operation, when it is performed in properly selected cases, is certainly a safe-and-sound procedure. The great mistake which has been made by surgeons is through their attempts to use the operation in cases in which it is unsuited. For instance, one finds in many instances a small ring type of carcinoma which is in a very long redundant type of sigmoid with a mesentery which is often six or eight inches in length. If that bowel is lifted up, if the bowel is turned and its edges sutured together so that it can be easily put down, with clamps which, when they are applied, will crush only the bowel wall and not the blood supply, a large amount of the bowel—that is, often six, seven, eight or ten inches long—with as much mesentery as one would wish to remove, can be removed. But in a case where obstruction is present with a dilated bowel and a lot of liquid material above it, and especially in case of a large, stout individual with a thick abdominal wall, who, in many instances, will be found to have a very short thick mesentery, if one attempts to drag a growth up through the incision, and has difficulty

in dragging it far enough out of the incision, one is very likely to have either sloughing of bowel from tension or to have metastasis occur in the abdominal wall

On the other hand, if one finds growths which are attached laterally much inflamed, as one frequently sees these growths, and if one goes and breaks up the adhesions and tries dragging them out, and there has been a great amount of contraction from the inflammation surrounding the growth, in that type of case one will stand a large chance of having metastasis occur in the abdominal wall

The Mikulicz operation, in the properly suited cases, is a very safe-and-sound operation, but it is often misused, and many of the bad results which one sees from it, and many of the metastases in the abdominal wall, come from efforts to use it in cases in which it is unsuited

DR REA SMITH (Los Angeles, California) remarked that he never felt safe with any suture line on the left side of the colon. He always felt safer when it was on the right. The reason a tube is not used as often as it should be is because it is so hard to have a nurse pass it during the operation. A great deal of trauma results and the operation is lengthened by the passing of a sigmoidoscope before the anæsthetic. But placing a tube up in the sigmoid and leaving it there he finds of great value because after the suture line it can be slipped through without any trouble.

DR DAVID CHEEVER said that for Doctor Haggard's blind cæcostomy he would substitute a high right transverse colostomy, for the reason that if the obstruction is in the colon 9 chances to 1 it is carcinoma, and if it is carcinoma 65 chances to 1 it is distal to that point. So if one makes a colostomy there one is going to relieve all the obstruction, completely divert the current, and give the best chance for a more radical operation at a later date. Whereas, if the lesion is carcinoma, and in the proximal colon, the cæcostomy does no good.

In regard to the Mikulicz operation, Doctor Cheever was surprised that his feeble attack on it did not bring out more objections because it seems to be so widely accepted throughout literature as, on the whole, the best procedure. The actual facts from the records of the Brigham Hospital which he quoted seem to justify him in taking the position which he did. They show, in brief, that the radical operations on the distal colon by the Mikulicz method carry a considerably higher mortality than those made by the open suture method, that the period of hospitalization is considerably longer, and that a much larger percentage were still incompletely healed when the patients were discharged from the hospital. The evidence as far as his small experience goes is very strongly in favor of the open suture resection after a preliminary colostomy, as against the Mikulicz.

Another thing, in perusing the house officers' memoranda of the subsequent cases in the hospital after the operation with the Mikulicz procedure, one constantly runs across such statements as "Application of clamp not satisfactory", "Clamp had to be re-applied", "Application of clamp quite painful", giving a distinct impression that the comfort of the patient after the Mikulicz resection is less than the comfort after the open suture resection.

To quote two authorities showing the wide divergence of opinion about the Mikulicz procedure. Coffey says, in a recent article, "Probably no more important principle has been introduced into intestinal surgery than the Mikulicz principle." And Bell, an English writer, says, "The Mikulicz procedure is grossly overvalued and should be abandoned except in certain instances."

Doctor Sistrunk, in an article on the Mikulicz method, lays down four conditions in which it is not suitable: (1) Growths with infection of the walls of the intestines (2) Large growths which are adherent (3) Obstructing growths (4) Patients with short mesenteries, and whose lesion is in the sigmoid.

That is a pretty large category which he lays down, and which he says himself are not the best type of case on which to employ the Mikulicz.

He certainly doesn't want to deny that the Mikulicz operation is a very possible and often a very good way of making an anastomosis in these cases, but the number

of cases in which it is superior to the open suture method, done in the simplest possible way, preceded by a permanent type colostomy which is subsequently closed, are very few indeed

DR W D HAGGARD said that his plea for cæcostomy was because of the ease and rapidity of its performance under local anæsthesia, and perhaps under spinal anæsthesia, and doing very little, preferably nothing at all, to the growth itself

One must not forget that one is operating on an intestinal obstruction. A cæcostomy is a life-saving procedure, just an enterostomy in the post-operative obstruction. If one does it under local, in the patient's bed, the patient is going to get well. If one does much to him one is going to lose him.

With the big tube one can get very good drainage, but perhaps not as well as if one puts in the double barrel. There is not much objection to putting it in—it is purely a technical thing. The point is to do as little to the patient as possible, in view of the frightful mortality. The trouble is made cutting the mid-line of the transverse colon. One does not know where the growth is.

DR WILLIAM J MAYO (Rochester, Minnesota) said that there is one thing one must think of after a while, and that is the colostomy. He had known good sensible men and doctors who would just as soon die some easy and convenient way as to live with a colostomy. He hoped the time is coming when one will not have to use so many permanent colostomies. He thought the time has arrived. We are struggling now to give people function, and normal function.

When one comes across the sea and one gets into St Lawrence Bay—when one comes across that way—one has about two days, a boat comes down and one gets some mail and newspapers. Under such conditions he gets a valuable thing out of an afternoon paper. Having nothing else to do he reads it clear through, advertisements and all. The thing that interested him most was the picture of a gardener. He was pulling a wheelbarrow behind him. He had a lot of plants, pots, and one thing and another in it. There was a boy, evidently about twelve or fourteen years of age, with his books under his arm. And, thinking about the mechanics of this, he said to the gardener, "Why do you pull the wheelbarrow behind you instead of pushing it in front?" "Well," was the answer, "I hate the sight of it so."

DOCTOR JONES (Boston) said that two fundamental principles in resections of the colon are (1) An adequate blood supply and (2) release of pressure on the line of sutures. If there is an adequate blood supply, and there is no pressure on the line of sutures, either by a colostomy or by a large tube in the cæcum, one will have no trouble. We have thought too much about the aseptic anastomosis and the kind of suture we should use, whether Pagenstecher or silk, or catgut, meanwhile, we have forgotten that it is a very difficult thing to have a proper blood supply in resections of the colon.

There are two sets of vessels. It isn't only the large vessels which can be injured. Of course, there is also the question as to whether the inferior mesentery can be tied and still have the lower portion of the sigmoid get sufficient blood supply so one can tie the left colic, the right colic, or the middle. But more important than that one should be able to tie any one of them. One must see each time that one has sufficient blood supply after one is tied.

More important are the vertical vessels from the arteries. They are terminal arteries. And that is the reason an end-to-end anastomosis is not as good as a lateral, so far as leakage goes. In doing an end-to-end anastomosis one may tie one or two of the vertical vessels. Doctor Jones had tied off two of the vertical vessels and had had necrosis of close to half an inch every time that that was done. He said it is quite easy to tie those small vertical vessels in an end-to-end suture and to get necrosis and leakage.

The other fundamental is the release of pressure on the line of sutures. It does not make a bit of difference what suture material is used or how carefully it is done—if one does not have the pressure and does have a blood supply, there will be no leakage.

# THE ACTION OF SODIUM CHLORIDE UPON THE SMALL INTESTINE

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IN THE investigation of the rôle played by sodium chloride in the body, the work of Hughson and Scarff<sup>1</sup> will always stand out as an initial stimulus for such experimentation. In 1924 these authors noted that the intravenous injection of hypertonic sodium-chloride solution would cause active peristalsis and suggested that post-operative distention, a mild form of ileus, might very well be avoided by the use of sodium-chloride solution. They report two cases of adynamic ileus successfully treated with salt after the failure of pituitrin, stupes and oral and rectal medication. Dreyer and Tsung<sup>2</sup> have also noted in experimental animals that hypertonic solutions of sodium chloride cause an increase in intestinal movements. No effect was noted by these observers when an isotonic solution was used. A number of French authors (<sup>3</sup> to <sup>12</sup>) have used hypertonic salt solution as a therapeutic agent in the various types of ileus. Their published reports are all favorable. Patry,<sup>13</sup> Battista,<sup>14</sup> Ross,<sup>15</sup> and Coleman<sup>16</sup> also record good results in clinical cases. The solution has been used in all cases to stimulate peristalsis.

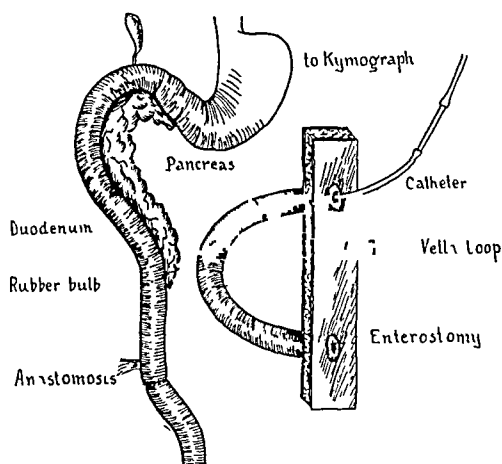


FIG 1—Thury Vella loop of upper jejunum

of sodium-chloride solution. Since distilled water, glucose solutions, sodium bicarbonate and other salts have no such action, it is concluded that sodium chloride plays a specific rôle in maintaining the water distribution and balance in the body as well as being an important factor in stabilizing the chemical balance. Hughson and Scarff have made the interesting observation that an intravenous injection of hypertonic salt solution decreases the ab-

In recent years the importance of sodium chloride in the treatment of intestinal obstruction and peritonitis has been frequently emphasized. One of the most interesting observations has been the relationship of salt to the chemical changes occurring in the blood, incident to obstruction of the small bowel. The rise in non-protein nitrogen and carbon dioxide combining power, and the fall of the chlorides as a result of high intestinal obstruction can be experimentally prevented and controlled by the administration

SODIUM CHLORIDE AND THE SMALL INTESTINE

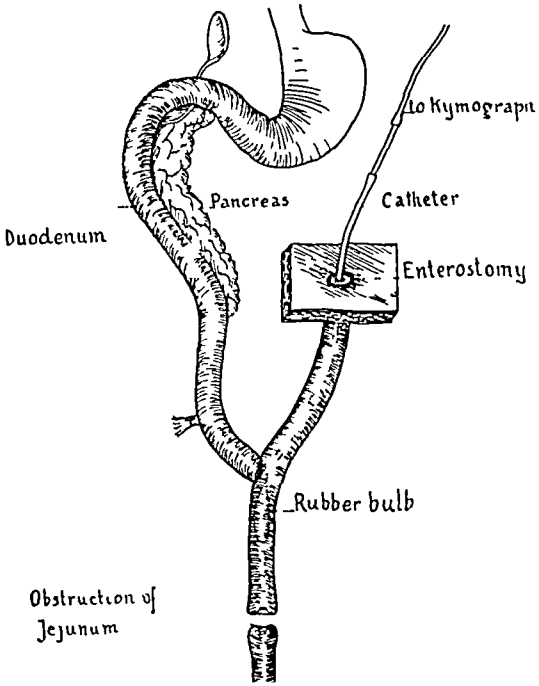


FIG 2—Jejunal fistula with obstruction of upper jejunum

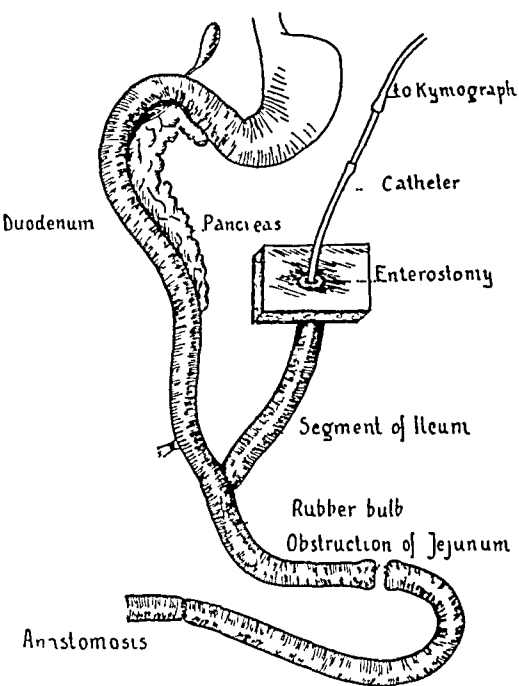


FIG 3—Jejunal fistula with obstruction of upper jejunum Segment of lower ileum used to produce fistula

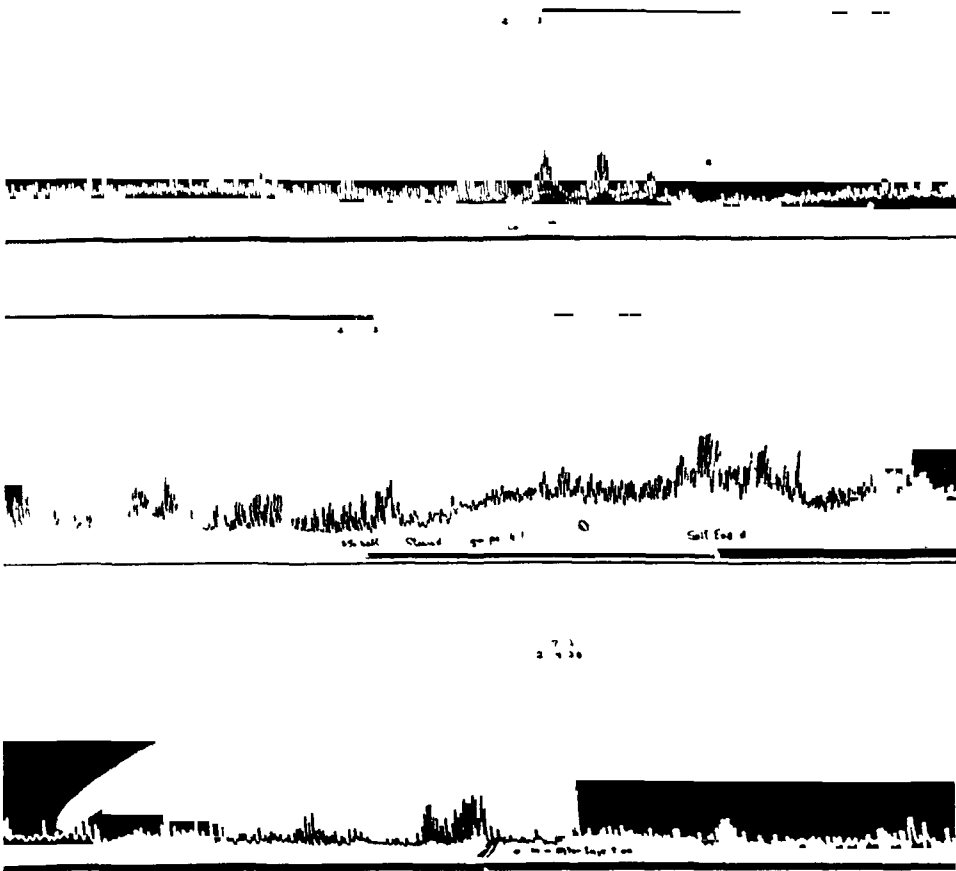


FIG 4—Thiry Vella loop Intravenous injection of 10 per cent sodium chloride solution, one gram of salt per kilo of body weight



sorption rate of water from an isolated loop of intestine. Experimental evidence presented by Carlson and Wangenstein,<sup>17</sup> Ochsner, Gage and Cutting<sup>18</sup> and others conclusively prove that the administration of hypertonic sodium-chloride solution stimulates both the intestinal tone and peristalsis. Lehman and Gibson<sup>19</sup> have noted that a 2 per cent solution of sodium chloride introduced into the stomach will stimulate forward peristalsis and relieve nausea and vomiting. It is probable that the sodium chloride acts directly upon the muscle of the bowel.

In a series of experiments on dogs we have tested the action of sodium chloride both before and after obstruction of the small bowel. In the first series a Thiry-Vella loop (Fig 1) was made and tracings of the normal intestine taken on kymograph records after administering intravenously salt and glucose solutions of varying concentration.<sup>20</sup> In the second series, a preliminary jejunostomy was done by two different methods. The first method used was a simple section of the jejunum about 12 to 18 inches below

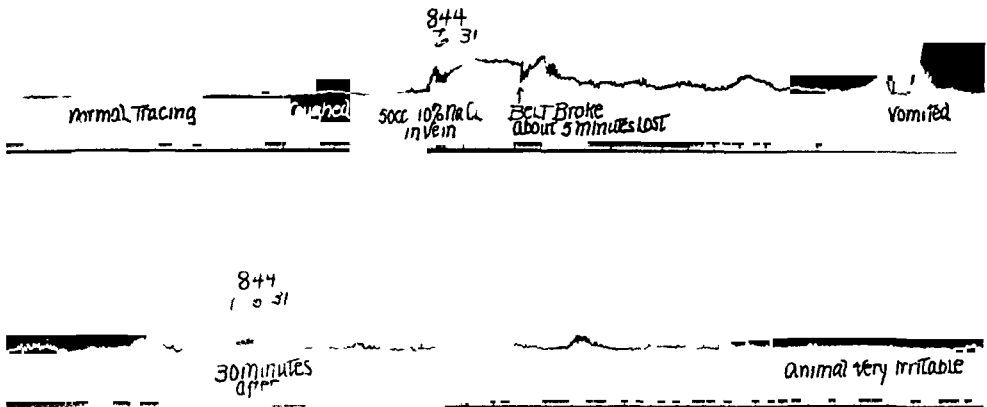


FIG 5—Kymographic tracing of upper jejunum forty eight hours after obstruction

the ligament of Treitz with an end-to-side anastomosis between the proximal segment and the jejunum below the site of section and a fixation of the cut end of the distal segment beneath the skin. After the wound was soundly healed the abdomen was reopened, the bowel obstructed about 12 to 18 inches below the anastomosis and the end beneath the skin opened, producing a jejunal fistula (Fig 2). The second method was that suggested by Mann and Bollman<sup>21</sup> and Scott and Ivy<sup>22</sup> in which a segment of the lower ileum was transplanted between the upper jejunum and the skin of the upper abdominal wall to produce a jejunal fistula (Fig 3). We prefer the latter method since there is less leakage of upper intestinal juices which endangers the life of the animal.<sup>23</sup> At the operation for obstruction of the jejunum, a rubber bulb with catheter attached was placed in the obstructed portion of the gut while the abdomen was opened. In some cases a slight constriction of the bowel was made with a ligature proximal to the bulb to prevent its regurgitation. In almost every experiment a hypertonic

## SODIUM CHLORIDE AND THE SMALL INTESTINE

solution of sodium chloride injected intravenously produced an increase in the gut tone and stimulated peristalsis of the jejunum (Figs 4, 5, 6 and 7) With the use of physiologic saline solution we have not been able to record any definite change in the gut activity as did Hughson and Scarff

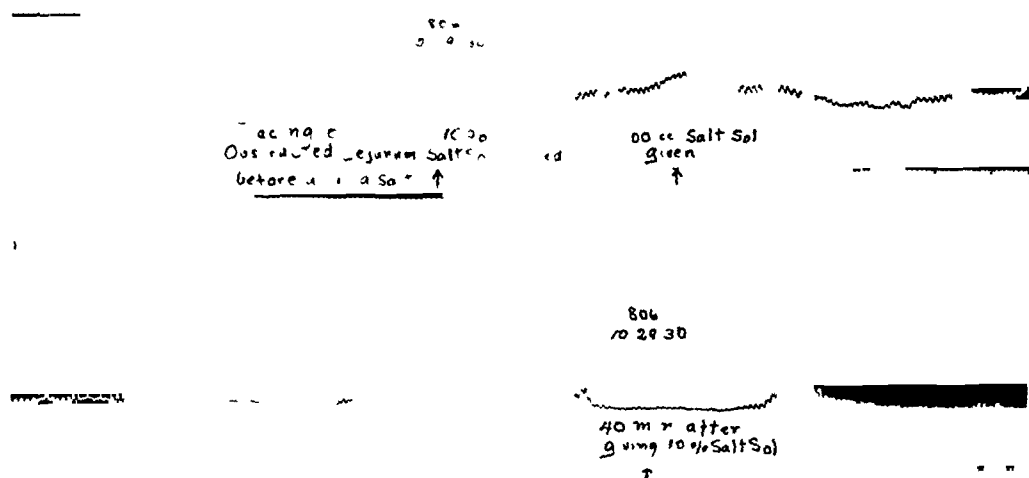


FIG 6—Tracing of upper jejunum forty eight hours after obstruction eighteen inches below the ligament of Treitz

Glucose has no noticeable effect on the bowel when injected intravenously Hypertonic salt solutions injected directly into the lumen of the bowel through the fistula cause active contraction of the gut with often vomiting and defecation within a few minutes In those animals having obstruction of the

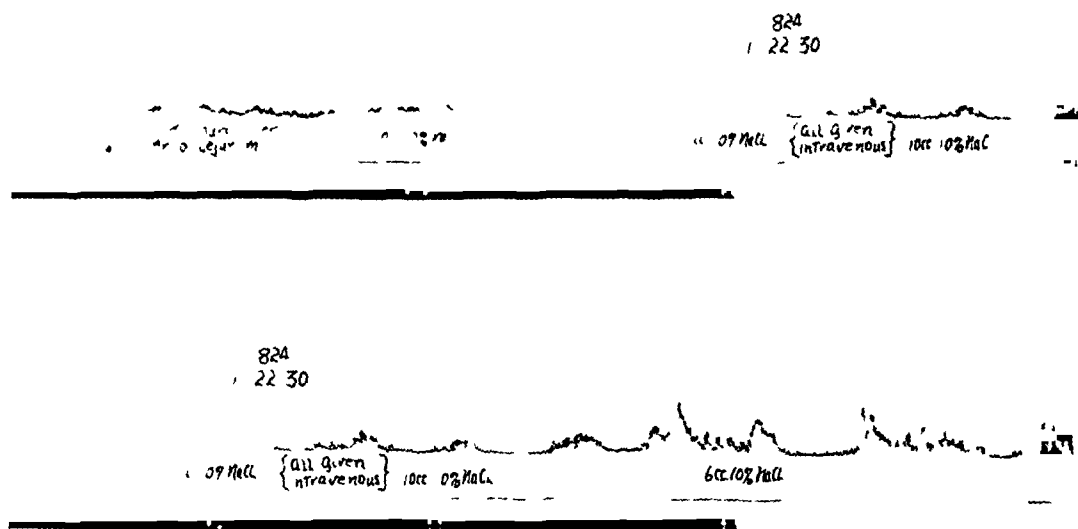


FIG 7—Tracing of upper jejunum ninety six hours after obstruction Repeated small doses of hypertonic sodium chloride

jejunum it was usually noted that the rhythmic contractions of the bowel were diminished and not infrequently there was some delay in the response to hypertonic salt solutions

Our results in the treatment of post-operative "gas pains" have been

quite striking<sup>24</sup> A high percentage of patients having abdominal pain associated with moderate distention respond to the intravenous injection of 20 cubic centimetres of a 10 per cent sodium-chloride solution with the passage of flatus and relief from pain It is frequently necessary to repeat this dose from one to three times In the more seriously ill patients with impending paralytic ileus or intestinal obstruction, 500 cubic centimetres of a 5 per cent solution is usually used as an initial dose if the blood chlorides are much below normal The importance of giving hypertonic solutions very slowly must be realized In the Kansas University Hospital we have adopted the rule that 20 cubic centimetres of a 10 per cent solution must be given over a period of five minutes and 500 cubic centimetres of a 5 per cent solution must consume at least one hour Given at these rates we have not had any bad results A local thrombus will at times form in a vein, rendering it unfit for immediate future use

In the treatment of patients having dehydration and hypochloræmia, it is essential to know that glucose is not a substitute for sodium chloride Gamble and Ross<sup>25</sup> emphasize this point when they state that sodium chloride is the only one of a long list of salts containing both of the ions specifically required for plasma repair It is, therefore, important to recognize the fact that a solution of sodium chloride acts as a specific in those patients having marked fluid and chloride loss

#### CONCLUSIONS

(1) Experimental studies and clinical observations indicate that sodium chloride in hypertonic solutions increases the tone of the small intestine and stimulates peristalsis

(2) The intravenous administration of hypertonic sodium-chloride solution as a peristaltic stimulant is indicated in post-operative distention with "gas pains," paralytic ileus, and as an adjunct to the treatment of intestinal obstruction after the obstruction has been relieved either by direct attack or by enterostomy

(3) The administration of sodium-chloride solution in proper concentration is considered a specific treatment for the dehydration and hypochloræmia incident to the various types of ileus

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# SPINAL ANÆSTHESIA

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THIS paper is concerned with a clinical analysis of spinal anæsthesia and with the status of our present attitude toward its usefulness. Countless articles on the subject indicate the general acceptance of this form of anæsthesia. Emphasis has been placed upon the desirable features and upon the technic of administration under such titles as "Controllable Spinal anæsthesia" and "The Safe Spinal Anæsthetic." A smoother convalescence and an absence of pulmonary complications were promised. We have been urged to use spinal anæsthesia in preference to a general anæsthesia in the poor risk case. Some advocate the adoption of this form of anæsthesia for every major procedure, irrespective of age, location of the operative area, or general status of the patient. There is a paucity, however, of clinical reports which include failures, fatalities and immediate or remote untoward effects. There has been a reversal in our opinion about certain features of spinal anæsthesia. Because of the well-recognized advantages from the standpoint of the surgeon, spinal anæsthesia will continue to be the anæsthesia of choice in a large proportion of cases. We are coming, however, to regard it as an anæsthetic of less potential safety and therefore not as applicable to the poor risk case as was first thought.

When the use of spinal anæsthesia was first revived three years ago on the Surgical Division B of the Hospital of the University of Pennsylvania, special charts for detailed notations about these cases were provided. Up to the present time 533 cases have been given a spinal anæsthetic and 78 per cent of these have been seen in the follow-up clinic or communicated with by letter.

The proprietary preparation known as "Spinocaine"<sup>1</sup> a novocaine, alcohol, starch solution, was used in the first 114 cases. Among this series there were nine failures of the drug to produce anæsthesia. We were very much concerned about the lives of two patients because of the development of a sterile meningitis. One patient lost control of the urinary bladder for three months. In this group of 114 cases there was one table death. The follow-up reports show, that in this early series only one had any untoward symptom later which might be attributable to the anæsthetic. After twenty-two months this patient still complained of paresthesias in the lower extremities. Neurologic examination was not significant.

We next changed to the use of Neocaine, a French preparation similar in formula and toxicity to Novocaine. The crystals readily dissolve in the spinal fluid. In this way fresh solutions are certain and no foreign material

other than the anæsthetic agent is introduced within the subarachnoid space. Minor changes in technic have been made from time to time. The following procedure has proven to be the most satisfactory. Ephedrine sulphate, 50 or 100 milligrams is given intramuscularly, thirty minutes before the administration of the spinal anæsthetic. The lumbar puncture is made with the patient on the side in the horizontal position. The most convenient lumbar intervertebral space is used in all cases. From 3 to 6 cubic centimetres of spinal fluid is withdrawn, the Neocaine crystals dissolved in it, and the solution slowly reinjected. Barbatage is not done. We have felt that the agitation of the spinal fluid by the plunger of the syringe is not a constant way to control the height of the anæsthesia. The patient is returned to the dorsal position and kept in the horizontal plane. A period of five to eight minutes is given for anæsthesia to appear. In most cases anæsthesia of the entire abdomen will be obtained with as small a dose as 150 milligrams of the drug. Should the anæsthesia not be high enough, the head of the patient is lowered and kept in that position only until the desired anæsthetic height is obtained. To keep the patient in the Trendelenburg position early invites a high anæsthesia with its added risk. The height of the anæsthesia, in our hands, has been more satisfactorily controlled by varying the position of the patient, rather than the site of the injection, the force of the injection or volume of fluid injected.

Should a significant drop in blood-pressure occur, the patient is put in the Trendelenburg position at once. Inhalations of carbon dioxide may cause a rise in the blood-pressure. Adrenalin has been the most effective drug to combat the acute hypotension associated with spinal anæsthesia, although at times no drug whatever seems to be of any value. We have not been impressed with the benefits derived from the use of vasopressin, caffeine, or strychnine. Chen and Schmidt<sup>2</sup> have shown that small doses of ephedrine might cause cardiac failure when injected after a prolonged period of low blood-pressure. They say "apparently a heart depressed by continued low blood-pressure, with consequent inadequate coronary flow, is more sensitive to the depressant action of ephedrine, and less responsive to its stimulant effect, than the normal heart." Should the blood-pressure fall to 50 millimetres mercury or below without a recovery in four or five minutes, an intravenous infusion of 5 per cent glucose is started.

The proximity that any single anæsthetic comes to the ideal can only be judged by an analysis in an unbiased way of the results in a large series of accurately recorded cases. We have found spinal anæsthesia completely satisfactory in 85 per cent of the cases. In 77 per cent it was necessary to give a general anæsthetic to complete the operation. One hour seems to be the average duration. The supplementing of a general anæsthesia at the beginning of the operation, was required in 37 per cent of the cases. No anæsthesia or an inadequate height was obtained in nineteen instances, an incidence of 36 per cent. Most of the failures occurred when the site of

the operation was to be in the upper abdomen although on three occasions the operative site was the inguinal region (See Table I)

TABLE I  
*The Success of Spinal Anæsthesia*

	Cases	Per cent
Total Number of Cases	533	
Entirely Satisfactory	453	85
Partially Satisfactory		
General Anæsthesia to finish	41	7.7
General Anæsthesia supplemented	20	3.7
Complete Failures	19	3.6
Spinocaine	9	1.7
Neocaine	10	1.9

The most disturbing and serious factor associated with spinal anæsthesia is the possibility of a marked fall in blood-pressure. A primary, then a secondary decrease in the blood-pressure may occur. The first or early blood-

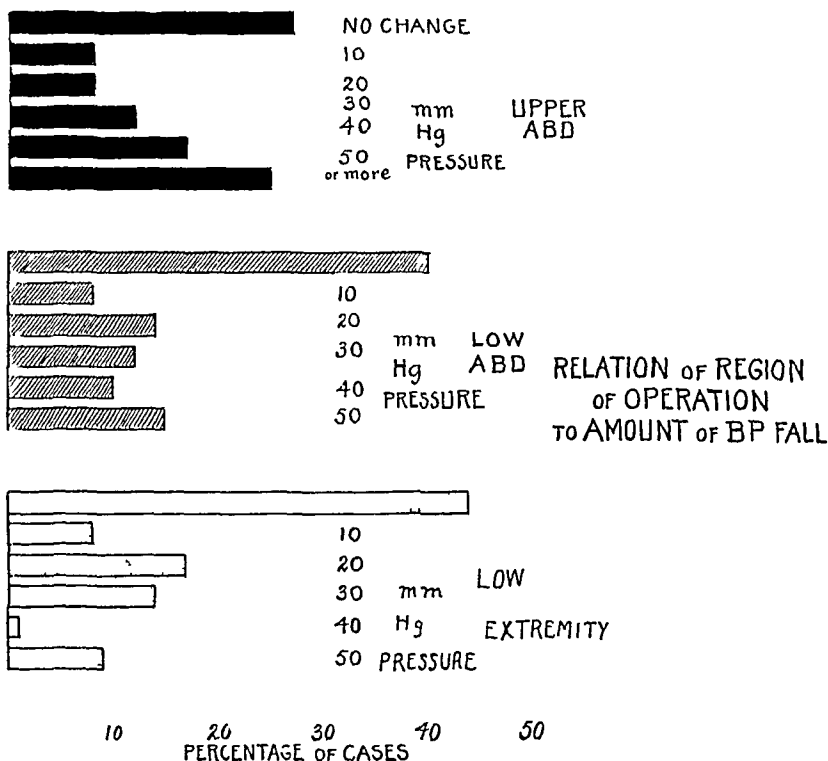


FIG. 1—Graph showing the relation between the region of the operation and amount of the blood pressure fall. The length of the columns indicates the percentage of cases in each group. The first column in each group represents the percentage of cases in which no change in the blood pressure occurred during the period of anesthesia. Between 30 and 40 per cent showed no change on matter where the operation was performed. It is interesting to note that 9 per cent of the patients who had an operation on a lower extremity were subjected to a blood pressure fall of 50 millimetres of mercury or more.

pressure change comes in the first twenty minutes and is dependent upon the action of the drug itself. The delayed or secondary fall is the resultant

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of a combination of factors, operative shock, loss of blood, a failing myocardium due to deficient coronary circulation and oxygen want or to a failure in adjustment of the vasomotor mechanism. The degree of the initial fall in blood-pressure must be dependent upon the percentage of the sympathetic fibres involved by the drug. The higher the sensory anæsthesia, as a rule, the lower the blood-pressure. With either Spinocaine or Neocaine and with the application of all of the well-accepted methods to prevent a decrease in blood-pressure, we have experienced a fall in about 60 per cent of the patients. The site of the operation has not materially affected the degree of the blood-pressure fall or the time that the maximum fall occurred. (See Figs 1 and 2.)

Surprisingly enough, the dosage of the drug has also had little effect upon the degree of the blood-pressure depression or upon the time that the maximum fall took place. A dose as low as 100 milligrams may be attended with a marked and alarming blood-pressure change. (See Figs 3 and 4.) It has been interesting to find that about 50 per cent of the cases leave the operating room with a lower blood-pressure than when the operation was started. This ratio is about the same, irrespective of the dose of the drug or the region of the operation. (See Table II.) We take issue with Koster<sup>3</sup> and others who consider lightly the hypotension associated with spinal anæsthesia. An immediate rapid fall is a sure sign that the anæsthetic agent has ascended to a high level. Following sensory anæsthesia and blockage of the autonomic nervous system, there is an ascending motor paralysis of the muscle of respiration. Until more is understood about the mechanism of the spinal anæsthetic deaths, the presence of a paralyzing drug in the upper spinal canal is to be considered a potentially dangerous state of affairs.

TABLE II  
*Blood-pressure at Close of Operation*  
Relation of Region of Operation and Dosage

	Blood-pressure Lower (Per cent)	Blood-pressure Normal (Per cent)
Operation in upper abdomen	57	43
Operation in lower abdomen	43	57
Operation in lower extremities	40	60
Dosage 100 milligrams (Neocaine)	55	45
Dosage 150 milligrams	47	53
Dosage 200 milligrams	57	43
Dosage 250 milligrams	47	53

This table shows the per cent of the patients who left the operating room with a blood-pressure lower than the normal pre-operative pressure for each respective case. Unless the final blood-pressure record had declined more than 10 millimetres mercury pressure it was included in the normal or no change group.

From the standpoint of patients who have a lack in vasomotor tone, a drop of 50 or more millimetres mercury pressure throughout the period of



the operation may leave the blood-pressure at an unrecoverable level. In eight cases, which died of shock a few hours after operation, the blood-pressure never was brought back from the low level induced by spinal anaesthesia. It is probable that the temporary spinal paralysis was a contributing factor in the initiation of the state of shock. Other conditions were present in all cases and the evaluation of the relative importance of the various contributing factors in each particular case is difficult. A brief resume of three such cases follow.

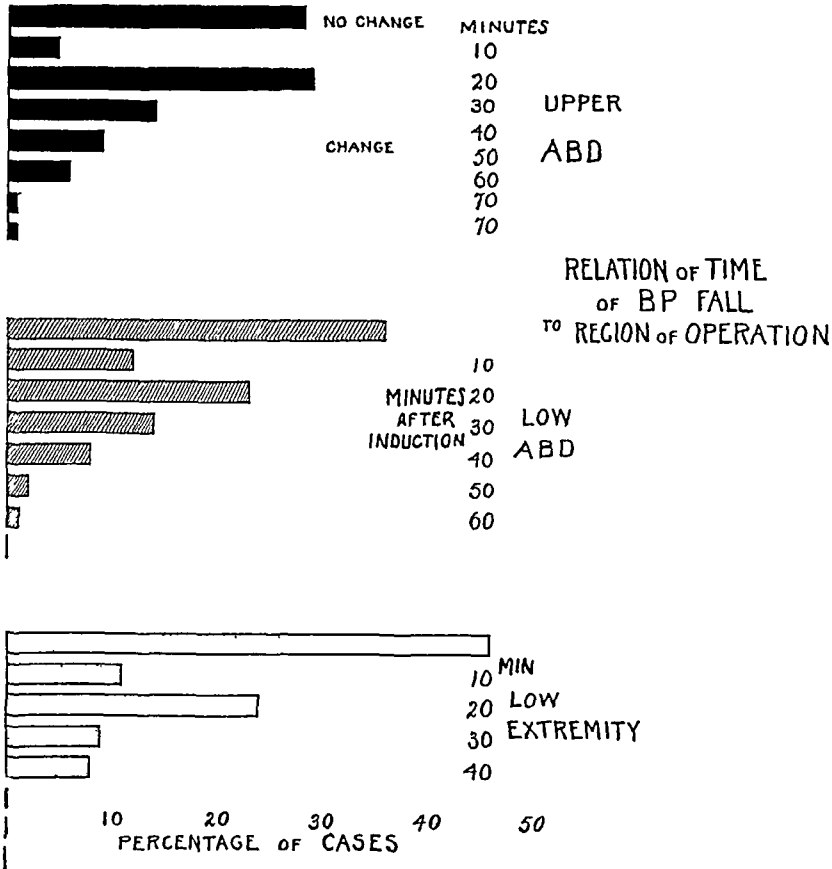


FIG 2—Graph showing the relation between the region of the operation and the time that the maximum decline in blood pressure took place. Note that in all of the groups the maximum fall in most patients, if one occurred, was twenty minutes after the induction of the anaesthesia. In the upper abdominal group a small per cent of the patients experienced the greatest fall in the blood pressure as late as fifty or sixty minutes after induction. These late falls in blood pressure represent the influence of associated factors incident to the operation or to the patient's disease.

**CASE I**—Mrs R M, aged fifty-eight. Gall-bladder disease, jaundiced four weeks. In hospital eight days for observation and pre-operative preparation. Blood-pressure 160/75, temperature, pulse, respiration normal. Ephedrine 100 milligrams given intramuscularly followed by spinocaine 3.5 cubic centimetres intraspinaly. Cholecystectomy and choledochotomy done. Liver showed a moderate cirrhosis. Duration of operation sixty minutes. Steady decline in blood-pressure to 110/70 during first thirty minutes. Blood-pressure on return to ward 100/60. Patient died thirteen hours after operation after being in extreme shock for one hour. Autopsy failed to explain cause of death. A small amount of blood was found in the right sub-diaphragmatic space.

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CASE II—Mrs I T, aged thirty-seven This patient had been operated upon for gall-bladder disease a year previously (elsewhere) A biliary cyst developed in the upper abdomen, was operated nine months later and adhesions prevented the identification of structures in the biliary area Jaundice persisted Patient was readmitted three months later and prepared for operation again Blood-pressure 120/74, temperature 99.6, pulse 86, respiration 20 Given ephedrine 100 milligrams intramuscularly followed by 200 milligrams neocaine A choledochoduodenostomy was done Duration of operation sixty-five minutes The blood-pressure fell to 90/60 during the last third of the operation but came back to nearly normal when taken from the table Upon

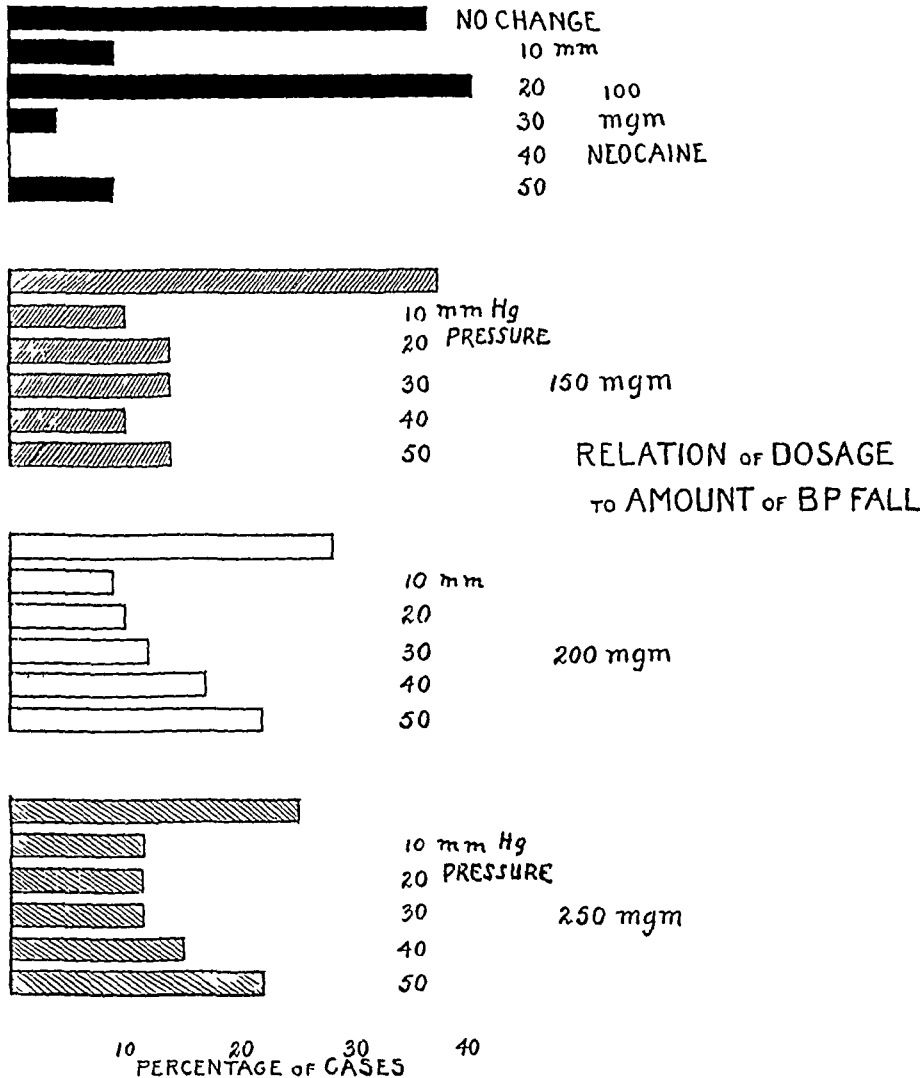


FIG 3—Graph showing the relation between the dosage of the drug used and the amount of the blood pressure fall Note that there is a slightly greater percentage of cases that showed a marked fall in blood pressure when the larger doses of the drug were used However the use of 50 or 100 milligrams may be attended with a marked change in the blood pressure

return to the ward the blood-pressure was 76/58 and did not go above that point Haemorrhage did not occur Intravenous glucose was administered The patient died eight hours after operation An explanation for death is wanting An autopsy was not permitted

CASE III—Miss E T, aged thirty-six Was originally operated for carcinoma of the ovary two and one-half years previously Was re-operated on three occasions since (elsewhere) Had persistent tachycardia around 120 during period of observa-

tion There was evidence of renal damage Blood-pressure 180/110 Was given ephedrine, 50 milligrams and neocaine, 200 milligrams Exploratory laparotomy for intestinal obstruction, subacute, and excision of metastatic lesion and lateral ileoileal anastomosis Operating time, seventy minutes Blood-pressure fell 70/40 during most of the operation and toward the end was brought up to 110/80 following intravenous 5 per cent glucose After return to room, blood-pressure never exceeded 130 systolic Death in thirty-one hours Uræmia acidosis or hæmorrhage was not in evidence At autopsy a left hydronephrosis and an early simple nephrosis on the right was found

Rapoport,<sup>4</sup> Arnheim and Mage,<sup>5</sup> McKittrick, McClure and Sweet<sup>6</sup> and Falk<sup>7</sup> have reported early post-operative deaths in which the spinal anæsthetic was held partly responsible It is our practice now not to give a spinal anæsthetic to any patient who before operation or who may during or after the operation, possess other conditions which tend to produce a low blood-pressure Burch, Harrison and Blalock,<sup>8</sup> have shown that animals under spinal anæsthesia do not stand hæmorrhage as well as those under general anæsthesia Our clinical experience supports their observation and further shows that other shock-producing agencies are not well tolerated The preliminary rise in blood-pressure that follows the use of ephedrine given thirty minutes prior to the spinal anæsthetic has served as a good index of the flexibility or reserve of the vasomotor mechanism Those cases which failed to show a rise with ephedrine were more likely to be depressed by the spinal anæsthetic

In this series there were two spinal anæsthetic deaths, a mortality of 0.37 per cent

CASE I—Mr J S, aged sixty-nine Symptoms and signs of intestinal obstruction of five days' duration Critically ill, flushed, distended and tense abdomen Had hemiplegia for four years Blood-pressure 124/90, temperature, pulse, respiration 100°-98-24 Intravenous saline, 1,000 cubic centimetres was given immediately and operation prepared Spinal tap dry Three cubic centimetres spinocaine was injected into what was thought to be the spinal canal Anæsthesia was secured to the level of the fifth thoracic segment The blood-pressure immediately fell to 65/0 Upon exploration of the abdomen a general peritonitis was found There was a volvulus involving the terminal ileum and a second point of obstruction in the small bowel produced by adhesions to the hepatic flexure At the conclusion of the operation there was a sudden cessation of respiration and of cardiac action simultaneously forty minutes after the anæsthetic was given Artificial respiration, stimulants and an intravenous infusion were administered The time of death, after forty minutes, would indicate that it was not primarily due to respiratory paralysis The prolonged hypotension, the result of a combination of factors, with the associated oxygen lack in all the tissues, including the medulla and heart is the most probable explanation for the death in this case Although this form of anæsthesia provided the most satisfactory relaxation for exploration of the abdomen, it was a mistake to administer it in the presence of other shock-producing factors

The second spinal death occurred late in our series when errors in technic or management were less likely and in a patient whose general condition was considered good

CASE II—Mrs A H, aged fifty-six This patient had had symptoms for one year, principally pain in the left lower quadrant of the abdomen Bed-ridden for four weeks Ascites and a mass in the lower abdomen were found General condition good

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Blood-pressure 160/80, temperature, pulse, respiration 99°-92-22 Two hundred and fifty milligrams of neocaine was given intraspinally The solution was made up with 4 cubic centimetres spinal fluid Barbatage was not done Anæsthesia extended to the third thoracic segment and the operation was begun There was a steady decline in blood-pressure and there was a simultaneous cessation of the heart and respiration twelve minutes after the induction of the anæsthesia The course of events, in this case, took place so rapidly that it is difficult to say what was the mechanism At the

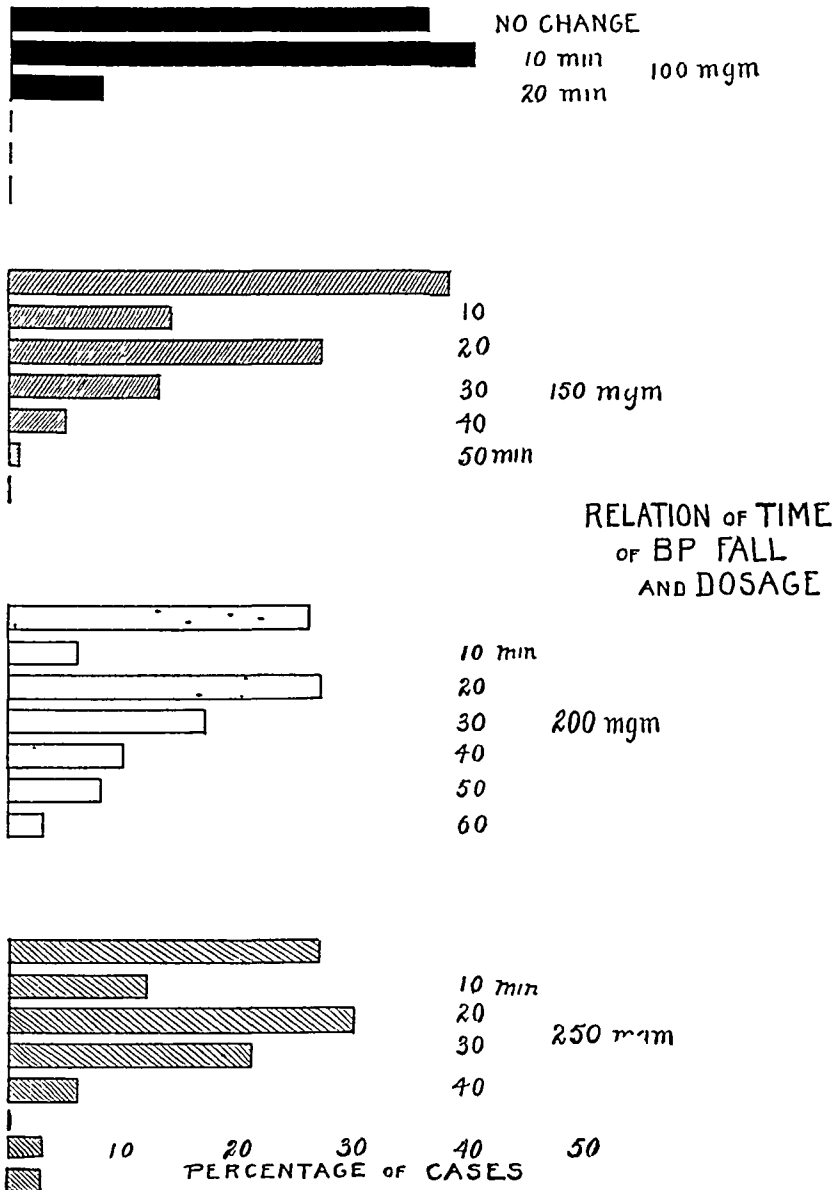


FIG 4—Graph showing the relation between the dosage of the drug and the time that the blood pressure showed its maximum change. It will be noted that the higher doses are attended with a larger percentage of cases showing the late blood pressure fall

time the blood-pressure was falling due to the anæsthetic, the abdomen was being opened and a large twisted ovarian cyst was being delivered Phrenic paralysis, medullary anæmia, or cardiac dilatation singly or in combination, might have taken place

In addition to acute hypotension or death, other less serious untoward effects of spinal anæsthesia have been noted (See Table III) Nausea was

present in 31 per cent of the cases and vomiting in 14 per cent. The frequency was greater if the operation was carried out in the upper abdomen. The anaesthetists were concerned about the respiratory activity or the patients complained of difficulty in breathing in 6 per cent of the cases. In two cases in which spinal anaesthesia was given for short lower abdominal operations, the patients went into a latent or secondary shock two and one-half and five hours after operation. There was a sudden fall in blood-pressure, difficulty in breathing, rigid abdomen and a disorganized type of upper costal activity without any evidence of diaphragmatic movement. It was thought that much of the peculiar course of events in these cases was due to the sudden appearance of pain.

TABLE III  
*Immediate Untoward Effects*  
(Percentages)

	Region of Operation		
	Upper Abdomen	Lower Abdomen	Perineal or Lower Exterior
Nausea	41	31	6
Vomiting	25	9	5
Respiratory Difficulties	8	6.5	1.6
Extreme Pallor	7	7.6	0
Cyanosis	2.2	0	1.6
Sweating	0.5	2.4	0
Shoulder Pain	4	2	0
Generalized Pruritus	0	1.3	0
Death During Anaesthesia (Two Cases)	0	0.7	0
Death During Anaesthesia, percentage of all cases			0.38

Untoward effects of spinal anaesthesia as encountered in the convalescent patient are relatively unimportant. (See Table IV.) Only 4 per cent complained of a transient headache and an equal small number had temporary urinary retention. Almost all of the patients who had difficulty in voiding had had inguinal or perineal operations. The incidence of such difficulties is as high with general anaesthesia. Two patients who developed signs and symptoms of meningitis, proved to have cloudy but sterile spinal fluid and both recovered. There were no residual effects in either case.

TABLE IV  
*Remote Untoward Effects of Spinal Anaesthesia*

	533 Cases	78 per cent follow-up	Cases	Pcr Cent
Headache			21	4
Voiding difficulties (Upper abdomen, 2, Lower abdomen, 17)			20	3.7
Persisting hypotension			8	1.5
Latent shock with return of sensation			2	0.4
Meningismus			2	0.4
Paresthesias lower extremity for two years			1	0.2
Tinnitus			1	0.2
Paralysis, any muscle group			0	0

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Pulmonary complications have been just as frequent, perhaps more so than when a general anæsthesia is used (See Table V) These figures coincide well with the findings of McKittrick, McClure and Sweet<sup>6</sup> who compared two surgical services at the Massachusetts General Hospital where spinal anæsthesia predominated in one and general anæsthesia in the other. There was a slightly higher incidence in the spinal group. During the past two years two patients have died as a result of bilateral lower lobe atelectasis. Autopsies were secured on both cases. We have never had such an experience with general anæsthesia. The slow, shallow type of breathing, the extreme relaxation of the abdominal and intercostal muscles and possibly a relaxation of the diaphragm because of sympathetic paralysis are possible explanations for the high incidence of such complications. All of these factors predispose to post-operative pulmonary hypoventilation as has been shown by Muller, Overholt and Pendergrass<sup>9</sup>.

TABLE V  
*Pulmonary Complications and Anæsthesia*

Type Operation	Spinal Anæsthesia Per cent Pul Complications	Deaths Per cent	General Anæsthesia Per cent Pul Complications	Deaths Per cent
Gall-bladder	4.8	0	0	0
Gastric*	6.2	6.2	10	6.2
Appendix	0	0	3	0
Hernia	2.3	0	0	0

\*Includes two cases of bilateral (lower lobes) massive atelectasis proven at autopsy.

Seventy-eight per cent of this series of cases were seen in the follow-up clinic or communicated with by letter. Only two patients complained of any symptoms which might have been late spinal anæsthesia effects. One complained of paresthesia of the inner side of the thighs since and for twenty-two months after a spinal anæsthetic. The neurologic examination of this patient was negative. Another patient complained of a tinnitus of moderate severity which was present since the induction of the anæsthesia.

### CONCLUSIONS

(1) Spinal anæsthesia carries with it a higher table mortality than other forms of anæsthesia in our hands. Its many advantages often outweigh the added risk that it carries and for that reason spinal anæsthesia has become a valuable adjunct to our present-day anæsthetic methods.

(2) Hypertension, hypotension or any condition which will in itself produce a hypotension during the course of the operation, constitutes a contraindication to the use of spinal anæsthesia.

(3) Open drop ether in the poor risk patient is the safest anæsthetic. Spinal anæsthesia is reserved for the good risk patient where the added dangers of the anæsthesia can be assumed in order to facilitate the technical operative procedure.

(4) Sudden deaths after operation should be charged up partially against spinal anæsthesia when the hypotension induced by this form of anæsthesia persists

(5) The site of the operation or the dose of the drug has a surprisingly small influence upon the degree of the fall in blood-pressure or in the time at which the maximum fall takes place

(6) The incidence of pulmonary complications is not reduced by spinal anæsthesia

DISCUSSION—DR ALEXANDER PRIMROSE (Toronto, Canada) said, in connection with spinal anæsthesia, from the standpoint of the general surgeon, he was not prepared to discuss the details of the technic of spinal anæsthesia, or the value of the different forms of technic, but he did know that in abdominal operations it makes the work of the surgeon infinitely easier. He would like to put it this way. If there are harmful results from spinal anæsthesia, if certain results are attributed to spinal anæsthesia—he was inclined to believe that one minimizes the amount of trauma to the viscera under spinal anæsthesia and he believed that one can lower the mortality very much by handling the viscera delicately and gently—spinal anæsthesia prompts the surgeon to handle the viscera with the minimum amount of trauma

As to the danger of the use of spinal anæsthesia in surgery above the diaphragm he recalled that one of his colleagues in Toronto, Doctor Shenstone's work has, at the present time, to his record eleven cases of lobectomy in which he has removed one lobe of the lung, and in some cases one lobe and part of another lobe. In these eleven cases he has had two deaths. The last six cases have been done under spinal anæsthesia. He is firmly convinced that the conditions under spinal anæsthesia are most favorable to a successful result in these cases.

DR HAROLD L. FOSS (Danville, Pennsylvania) said that in a paper on the question of anæsthetics presented in Philadelphia a few weeks ago by a distinguished member of this Association, a man for whom we all have the highest regard, spinal anæsthesia is summarily discarded as are nearly all means of producing anæsthesia other than ethylene or ether or infiltration. This paper was not discussed. It will be read by thousands of physicians and surgeons in the country and its conclusions will be accepted by many, but he thought it should not go unchallenged.

He was greatly interested in determining if he were correct in his conclusions that spinal was proving, in his hands, a satisfactory and, what is even more important, a safe anæsthetic. In going over the records he discovered that his mortality, in general abdominal surgery, had dropped materially since he began, in certain cases, to use spinal anæsthesia in place of ether, a decrease that could be directly attributed to the change in anæsthetics. It was not only apparent in the general list but proved so in operations for specific conditions. In reviewing his first 200 consecutive cases of acute appendicitis performed under spinal and comparing them with the 200 preceding these and operated on under ether. Over 70 per cent of these patients had peritonitis when they reached him and the operations were all performed by him, in the same hospital, with the same personnel, and the same pre-operative and post-operative care, everything being equal except in the first 200 cases ether was used, in the following 200, spinal. There was an immediate reduction in mortality from 7.4 per cent to 4.2 per cent.

He then investigated his cases of acute perforating duodenal ulcer, his cases of acute intestinal obstruction and those of biliary tract disease. In all there was a definite, and he felt, significant decrease in mortality following his adoption of spinal in place of ether as an anæsthetic. Staff members are thoroughly convinced from the analysis of these results that the change in anæsthetics has, undoubtedly, brought about a definite reduction in mortality.

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As to the question of the patients choosing the anæsthetic, the speaker never thought it necessary or even advisable and has always felt that it is better to educate his patients to be willing to leave such questions, as they do the question of operative technic, entirely to the best judgment of the surgeon in whom they should have complete confidence. He does not discuss the matter with his patients who have, however, in a vague way, an idea that he uses spinal anæsthesia and he has never had the slightest trouble in this respect in over 1,600 spinal anæsthesias. It may be of some interest in connection with this discussion to state that, in our own clinic, where spinal has been extensively used for the past two years, twenty-eight persons in our hospital staff have recently been operated upon and all selected spinal anæsthesia.

All of us realize that the method possesses certain dangers. No anæsthetic is devoid of them all. But it has tremendous advantages far outweighing its dangers which, in the long run, makes it a most desirable anæsthetic and one which, rather than increasing mortality, will, especially in certain bad risk cases where relaxation is desirable, as in acute appendicitis with peritonitis, intestinal resections in acute intestinal obstruction or in carcinoma of the colon, the closure of visceral perforations, *etc.* be the direct means of saving life.

Spinal anæsthesia has acquired unusual popularity in the past few years and, it is true, in a few hands has been badly used. Such a condition must be expected with all newly developed procedures in surgery, whatever they may be, yet it does not justify the unqualified condemnation of the method by those who have had no experience with it and those of us who have found spinal of tremendous aid should not be forced to discard it merely because of personal prejudices which have been engendered largely by reports of those who, because of inexperience with the technic, have had unsatisfactory results. His conviction is that spinal anæsthesia is one of the great contributions to surgery, that it is extraordinarily satisfactory in its present state, that, in the majority of general major surgical procedures performed below the level of the diaphragm it is the anæsthetic of choice, that, in all probability, from the laboratory of the biochemist will ultimately come newer drugs probably of a synthetic nature which, used intraspinaly, will produce a most satisfactory anæsthesia without even the slight tendency to untoward results spinal may now possess but which, when compared with inhalation anæsthetics in general, especially ether, are practically negligible.

DR FRANCIS A. C. SCRIMGER (Montreal, Canada) said that he had been recently using spinal anæsthesia a good deal more than formerly. One point that comes out is that when one has realized that a patient can be held in a rather head down position, that has seemed important to us, and has avoided very largely the enormous drops in blood-pressure.

Possibly spinal anæsthesia as a term is not exactly accurate. It is very largely a root anæsthesia and for that reason a head down position is not objectionable. It is really not the spinal cord that is made anæsthetic but the roots of the nerves as they leave the spinal cord. For that reason it gives a greater degree of confidence and avoids a good many fears.

DR GEORGE P. MULLER (Philadelphia, Pennsylvania) rejoined that he had done two cases of thoracic surgery and five tumors of the breast, under spinal anæsthesia, but he did not think he would do it again. He believed that enough of them would raise the mortality, at least with the present drugs. He did not think spinal anæsthesia could reduce the mortality of acute appendicitis except insofar as here and there it makes a difficult operation a little easier. The mortality of appendicitis varies so with the kinds of cases one gets, the percentage of drainage cases, the time the doctors send them in, *etc.* In his last 200 cases his mortality is about 2 per cent. He does not claim any credit for that because he had a long run of easy cases. Our appendicitis cases, as a rule, are done under general anæsthesia because the operation can be done fast. He preferred not to anæsthetize a patient with something that was going to send him to a



ward anesthetized for an hour when he could do the appendectomy practically always in twelve to twenty minutes. So we use local anæsthesia and just enough gas to keep them quiet.

There were times when he did use a spinal. For perforated ulcers it is perfect. One gets rid of the rigidity, which is never touched by a general anæsthetic, and enables one to do better work.

Doctor Scrimger spoke of the head down position. If one uses the neocaine solution it has a tendency to run down. Since they changed to neocaine he finds it necessary to keep them flatter. And here also is where one is in between two difficult positions. If the patient has a tendency for the neocaine to work itself upward in spite of the flat position, in spite of a small dose, as it does in some patients, if one puts them in that head down position very often it drives the anæsthesia to a still higher point. So he tries to hold off just a little bit until the glucose solution gets started which tends to bring them up. Then, after twenty minutes' time or thereabouts, if necessary, if the hypotension is still prolonged, he holds them in a head down position.

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# CLINICAL EXPERIENCES WITH GWATHMEY'S COLONIC OIL-ETHER ANÆSTHESIA

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COLONIC anæsthesia was first administered by Gwathmey at the Stuyvesant Square Hospital (formerly the New York Skin and Cancer Hospital) in 1914. The Stuyvesant Square is a special hospital devoted to the treatment of skin and cancer. The cancer service is a separate entity and deals with all forms of cancer. The therapy has been chiefly surgical. The hospital tradition stands for the most thorough cancer surgery. The technic as used today has been built up by the labors of Willy Meyer, Foot, Eggers, Semkin, Torek, Kennedy, Morrow and others. The criterion for operation has been the extent of the cancer rather than the condition of the patient. We believe that the possibilities in safely prolonging the operation and the development of a meticulous cancer technic has been greatly enhanced by the employment of colonic ether. The direct result of all this being an improvement in the percentage of apparent cures.

In the administration of this anæsthesia two distinct processes take place. The first is the physical separation of the ether from the oil, the second, the physiologic absorption of the liberated ether vapor. The dissolution of the mixture in the colon is at a constant rate and the total vapor liberated is limited by the amount of ether used. From a mixture containing 6 ounces of ether, the ether is absorbed at the rate of 2 ounces per hour, this produces the required saturation of the blood for anæsthesia. The constant elimination by way of the lungs prevents the cumulative effect which may occur in the inhalation method. In this type of anæsthesia, the higher centres of thought, speech, *etc.*, are not so profoundly affected and amnesia is marked. The safe prolongation of the operative time is made possible by the fact that the stage of anæsthesia is followed by a stage of analgesia lasting sometimes as long as eight hours.

Since the inception of colonic anæsthesia the method of administration has undergone few changes. Experience has shown that the most successful amount is 5 ounces of ether and  $2\frac{1}{2}$  ounces of oil, to be given one hour before operation. Many methods of administration, such as the fractional doses, Murphy drip, *etc.*, have been tried and discarded. The use of soap-suds enemata and excessive colonic washings, *etc.*, have been found to be irritating to the mucous membrane of the bowel and have also been abandoned. With the use of 5 ounces of ether it has been found necessary to employ some supplementary anæsthesia in 65 per cent of the cases. Nitrous oxide ether and chloroform have been used. Small amounts of chloroform are

preferred, the ether seemingly counteracts the depressing effect of chloroform. There have been no complications from the chloroform. No supplementary anaesthesia is required unless the patient is actively restless.

*Technic*—On the evening preceding the operation the patient is given a light supper of tea and toast, nothing is allowed by mouth after midnight. No laxatives are given at any time, the cleansing of the bowel being accomplished by tap-water enemata. The administration should take place in a quiet and darkened room. At 5 A.M. on the morning of the operation the tap-water enemata are repeated. One and a half hours before the operation a chloretone suppository of 10 to 15 grains is given to be followed in fifteen minutes by a hypodermic of morphine sulphate grain  $\frac{1}{6}$  to  $\frac{1}{4}$ . Fifteen minutes later, with the patient in the left Sims' position, the following mixture is instilled into the rectum: ether ( $\frac{3}{4}$   $\bar{V}$ ), olive oil ( $\frac{3}{4}$   $\bar{IIS}$ ), paraldehyde ( $\frac{3}{4}$ ). It is essential that this be thoroughly mixed and given very slowly, at least ten to fifteen minutes being taken. A few patients suffer cramp-like pains in the abdomen and if their cooperation cannot be obtained they will expel the mixture. At the end of an hour in which there has been absolute quiet the patient is taken to the operating room. Immediately on return to the ward a colonic irrigation of tap water is given, followed by a retention enema of 6 ounces of hot coffee. Throughout the entire preparation and operation the patient should be closely supervised to prevent the danger of the tongue falling back in the throat.

The character of the anaesthesia obtained. The patient is analgized and carried on the threshold of surgical anaesthesia. Reliance being placed on the marked analgesia properties of colonic ether. Analgesia with consciousness is present in the majority of cases. Colonic anaesthesia produces relatively more analgesia than anaesthesia and often in late stages of an operation the patient is apparently completely conscious, yet the amnesic properties are such that the patient will not remember anything that took place in the operating room. Ether oil is always safe as a light narcosis and the eye lids and other reflexes are active, the patient relaxed and analgized. The ideal colonic anaesthesia yields a quiet and peaceful respiration in which the swallowing and respiratory reflexes are retained. Some of the most difficult and time-consuming operations about the head and neck can be successfully carried out as there is no venous congestion and no excessive production of saliva and mucus. The patient can be readily aroused by talking sharply to him.

*Contraindications*—It cannot be used with advantage in cases requiring complete muscular relaxation. As the reflexes are not abolished in the throat it is not a good anaesthesia for the ordinary tonsillectomy. It is contraindicated in diseases of the gastro-intestinal tract and rectum.

The post-operative recovery is smooth and takes place with fewer complications than in the inhalation method. There is little post-operative nausea and vomiting, fewer cardiac and pulmonary accidents. This was the deciding factor in changing from the inhalation method to the colonic and has

brought about a decrease in the death-rate and has lessened the post-operative complications, especially in head and neck cases

*Local complications*—In the last 800 colonics there were six cases of colitis, eighteen cases of abdominal pain, five cases of diarrhœa, four cases of irritation of the rectum, three cases of aggravation of the hæmorrhoids, a total of thirty-six Expelled colonic (failures) twenty-seven, an excess of ether was used in eighteen leaving 94.53 per cent of successful colonic administrations

In the series of 2,150 operations under colonic ether there were 159 deaths Thirty of these are recorded as errors in judgment, there were fifteen cases in which simultaneously with the removal of the carcinomatous lesion a bilateral block dissection of the neck was performed This particular procedure gave a mortality of 44.1 per cent and consequently was abandoned There were sixty-two surgical deaths classified as shock, infection and hæmorrhage, thirty-nine from pneumonia (non-anæsthetic), three from emboli, seven from secondary hæmorrhage, twelve from cancer cachexia, one from delirium tremens, and five from colonic anæsthesia

*Summary of deaths from colonic anæsthetic* (1) *Thorocoplasty*—The operation lasted three hours and the patient left the table in poor condition and died the same day At autopsy the colon was distended and congested It is questionable whether colonic anæsthesia should be used in such a case, as the safety of this method depends, to a large extent, on the escape of the ether during respiration

(2) *Excision of a carcinoma of the jaw* and cervical lymph-nodes, this operation lasted two hours, the patient returned to the ward in good shape and died on the third day *Autopsy findings*—Atheroma of the aorta and ulcerations of the large intestine

(3) *Epithelioma of the lower lip*—No operation was performed After the administration of the colonic anæsthesia there was a short period in which he was not supervised When the anæsthetist came he found him dead in bed with the tongue in the back of the throat *Autopsy findings*—Atheroma of the aorta with distinct congestion of the colon

(4) *Radical resection of the right cervical nodes* which lasted two hours The patient was returned to the ward in fair shape There was difficulty in keeping the tongue forward The nurse was called away and when she returned twenty minutes later the patient had ceased breathing Clinically these two cases died from swallowing their tongues

(5) *Excision of carcinoma of the face* and cervical nodes The operation lasted five hours, the patient returned to the ward in good condition and died on the thirty-seventh day *Autopsy findings*—Necrosis of the rectum and bronchopneumonia The direct cause of death was an ulcerative colitis produced by an incorrect mixture The convalescence of two other cases who received the same mixture was delayed by ulcerative colitis

The last fatality from colonic anæsthesia occurred in 1925 For the proper evaluation of the safety of the method it is necessary to consider the age, condition of the patient and the extent of the operation required Over 50 per cent of the patients were fifty and over, 420 were between fifty and sixty, 292 between sixty and seventy, 80 between seventy and eighty and 12 between eighty and ninety One thousand four hundred and thirty-eight were head and neck cases Twenty-four per cent of the operations lasted three

hours, 17·2 per cent lasted four hours, 10·1 per cent lasted five hours, 2·4 per cent lasted six hours, 0·7 per cent lasted seven hours, 62 per cent lasted eight hours. During the corresponding period, 1 532 inhalation anæsthesias were administered. The demonstrated increased safety and the diminished complication rate of colonic ether as compared to that of inhalation anæsthesia led to the abandonment of the inhalation method in all head and neck cases.

**The disadvantages of colonic anæsthesia.** It is not a universal anæsthetic, it does not give complete muscular relaxation, it is a complicated and time-consuming method which requires the cooperation of the patient for its administration and a competent person to watch the patient before and after the operation to prevent the swallowing of the tongue. The patient, unless under constant supervision, should never be allowed to lie flat on the back. It should not be used in emergency operations as time is required for the proper preparation of the rectum.

**The advantages are.** It is safe, it is controllable, as the ether can be washed out at any time. The prolonged analgesic properties of colonic ether (it may last from six to eight hours) make it possible to carry out extended operative procedures. Psychic trauma is absent, amnesia marked and the stage of excitement eliminated. The actual cautery can be used in the mouth and throat. It is useful in short-necked, obese individuals in other types of operation.

*Summary*—The following conclusion is based on the 2,150 cases of colonic ether anæsthesia with an anæsthetic mortality of five cases (0·24 per cent). Colonic ether anæsthesia is the safest and best for all patients with cancer of the head, neck, *etc.*, whose lesions require a general anæsthetic for their proper removal.

*Comment*—In order to shorten the preparatory period of anæsthesia we have been employing a mixture of avertin and oil ether. We are not yet ready to pass judgment on this procedure as we still consider it in the experimental stage.

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# RESULTS OF SPLENECTOMY IN SPLENIC ANÆMIA, HÆMOLYTIC JAUNDICE, AND HÆMORRHAGIC PURPURA <sup>†</sup>

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SPLENECTOMY for certain types of anæmia and blood dyscrasia associated with disorders of the spleen is a modern surgical venture. Its development, in the absence of accurate knowledge of the function of the spleen in health and disease, has been attained entirely through empiric failures and successes. Although the beginning of an active interest in splenectomy may be said to date back only a quarter of a century, so far the operation has been employed many hundreds of times in a wide variety of diseases, therefore ample data, with regard to the operative results in certain of the more common diseases, have long been available to establish the procedure on a firm basis.

Notwithstanding the remarkable advances made in this branch of surgery, it is unfortunate that, today, many surgeons are unacquainted with these achievements. In consequence there are undoubtedly many cases of disease in which splenectomy is indicated, but which are not correctly diagnosed, nor the proper treatment undertaken. To substantiate this statement, it is only necessary to call to mind the prevailing view of the extremely hazardous nature of the operation, and the very common mistakes made both in diagnosis and in institution of treatment, often complications rather than diseases themselves are treated.

There are several reasons to account for the fact that knowledge of the results of splenectomy has not been more widely disseminated. As the diseases benefited by removal of the spleen occur comparatively rarely, relatively few surgeons have had sufficient personal experience on which to base definite convictions. In addition, published reports, the remaining source of information, have shown an exceedingly wide variation in results. For instance, the operative mortality has been reported as 10, 30, or 40 per cent, or even higher. Unless due consideration be given to the nature and details of these reports, their apparent contradictions would tend to create doubt and confusion. Reports of operative results based on data accumulated for many years, and collected from many hospitals, often do not reflect the true status of the operation primarily because of the variable personal factors involved. This would seem to be especially true in surgery of the spleen, in which discrepancies in diagnosis and differences in case would necessarily affect adversely the record of operative results.

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<sup>†</sup>The author acknowledges indebtedness to Dr M G Beaver for assistance in tabulating the data.

It seems timely, therefore, to make a critical analysis of the results of splenectomy in the more common diseases, concerning which sufficient data are available to warrant drawing conclusions. For this purpose, a study was made of the records of all cases of splenic anæmia (including Banti's disease), hæmolytic jaundice, and purpura hæmorrhagica, in which splenectomy was performed at The Mayo Clinic between December 31, 1908, and January 1, 1931. The series comprised 326 cases in which splenectomy was performed, in 167 of which the reason for operation was splenic anæmia, in 118, hæmolytic jaundice, and in forty-one, purpura hæmorrhagica. The clinical diagnosis was made in each instance by Giffin and his associates.

Since this paper is restricted to presentation of the results of operation in these diseases, consideration of the physiology and pathologic changes relative to the spleen, the pathogenesis of the diseases, the details of operative technic, and the general indications for splenectomy in other disorders have been omitted. However, for purposes of clarity, the prominent clinical and hæmatologic features on which a diagnosis was based, are summarized briefly. Many of the data used in this study have been published in papers by W. J. Mayo, and by Giffin.

*Splenic anæmia*—Osler defined splenic anæmia as "Intoxication of unknown nature, characterized by great chronicity, primary progressive enlargement of the spleen which cannot be correlated with any known cause, anæmia of secondary type, with leucopenia, a marked tendency to hæmorrhage, particularly from the stomach (œsophagus), and in many cases a terminal state with cirrhosis of the liver and jaundice." It is the late stage of anæmia, that is, the stage in which there is secondary involvement of the liver, as manifested by evidences of portal obstruction and hepatic insufficiency, that today is commonly designated as Banti's disease. Strangely enough, in the presence of an enlarged spleen and associated anæmia, the diagnosis of this syndrome rests on the absence of any known etiology, and it is little wonder that many observers question whether splenic anæmia should be considered as a clinical entity, for if the cause of the splenomegaly is identified, the diagnosis of splenic anæmia is forthwith excluded.

The course of the disease in cases in which operation has not been done is progressive, without any tendency toward abatement or spontaneous recovery, and the patient ultimately succumbs, usually within a few years, as a result of recurrent excessive hæmorrhages or hepatic insufficiency. The first manifestation of this syndrome is often discovered by the patient, or in a routine examination, as enlargement of the spleen, and in some instances the organ attains considerable dimensions without other recognizable evidence of the disease. Commonly, however, there are alterations in the blood when the patient presents himself for examination. These consist of secondary anæmia of varying degrees, and extreme poikilocytosis, leucopenia with lymphocytosis is not uncommonly present, but the leucocytes may be normal in number or even slightly increased.

One or more episodes of copious hæmorrhage from the gastro-intestinal

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tract, usually from œsophageal varices, occurred before operation in ninety-eight cases (59 per cent) of this series. These are more common in the late than in the early stages of the disease, but, not uncommonly, sudden severe hæmorrhage from the gastro-intestinal tract is the patient's first warning that he is sick. Thirteen patients in this group with hæmorrhagic splenic anæmia had been treated for peptic ulcer. About a year ago during the course of a roentgenologic examination of the stomach of a patient suffering from splenic anæmia, unusual shadows were seen that suggested hugely dilated œsophageal varices, later this impression was confirmed by means of the œsophagoscope. Since then, roentgenologic examination of the œsophagus has been adopted as a routine procedure in all cases of splenic anæmia. Subsequently, similar evidence of œsophageal varices has been discovered on roentgenologic examination in other cases of splenic anæmia, in one of which clinical evidence of a hepatic condition was lacking. Likewise, a test of hepatic function, based on retention of bromsulphthalein, often indicates definite injury to the liver that otherwise would not have been suspected from clinical examination.

Of the 167 patients with splenic anæmia and Banti's syndrome who were subjected to splenectomy, sixteen died in the hospital, an operative mortality of 9.6 per cent. The sixteen deaths included one by suicide. The causes of death of the remaining fifteen patients cannot be accurately classified, for in some instances the pathologist was unable definitely to distinguish from several possible contributory conditions the immediate cause. Broadly, however, it may be said that pulmonary infections, including pneumonia, pleurisy with septicæmia and hæmorrhagic œdema of the lungs accounted for four deaths, pulmonary embolism for two, portal thrombosis for three, hepatic insufficiency for four, and subdiaphragmatic abscess and peritonitis each for one death.

Of the 151 patients who survived the immediate effects of the operation, eighty are known to be living, three of them eighteen years after operation. Two are still living, fifteen and seventeen years after operation, and fifteen have lived from ten to fifteen years. Ten of the sixty-eight patients who recovered from the operation but who died later lived for more than nine years, one for eighteen, one for thirteen, and three for twelve years. Although the causes of many of the subsequent deaths were not attributable to the disease itself, it is of interest that more than a third were directly attributable to hæmorrhage.

The number of patients in the series is too small to permit accurate statistics regarding the influence of sex on the operative results, but records of the deaths in hospital suggest that the operation is more hazardous if the patients are females. Seven of the ninety-seven male patients, and nine of the seventy female patients died in the hospital. However, there were no appreciable differences in the end-results as regards the sexes. Age (Table 1) played a more definite part in the immediate as well as in the late results. If the patients are divided into two groups, it will be seen that the operative



mortality of those aged less than forty years was only half that of patients aged more than forty years, about 53 per cent of patients aged less than forty years are still living, whereas only 40 per cent of those who are older are alive

Owing to the difficulty of accurately estimating the functional efficiency of the liver, it is not possible to determine with exactness the influence which secondary hepatic injury has had on the operative results. Except in the more advanced cases, in which evidences of cirrhosis and portal obstruction are obvious, it is not always possible from clinical data to judge accurately the degree of hepatic injury. Likewise, in some cases in which gross changes characteristic of advanced cirrhosis are lacking, the surgeon is often unable, from observation of the size, color, and consistence of the organ, to estimate

Table 1

Splenectomy for splenic anemia

Age by decades	Cases	Hospital mortality	Subsequent deaths	Living	Well	Fair	Poor	Not traced
0 - 9	11		5	5	4	1		1
10 - 19	19	2	7	10	8	2		
20 - 29	42	2	15	24	21	2	1	1
30 - 39	40	4	16	20	13	4	3	
40 - 49	30	3	14	12	10	1	1	1
50 - 59	20	4	8	8	7		1	
60 - 69	5	1	3	1		1		
Total	167	16	68	80	63	11	6	3

the degree of injury. In livers adjudged on gross examination to be only slightly enlarged or congested, microscopic examination of specimens removed for diagnostic purposes has demonstrated repeatedly the presence of marked hepatitis or degeneration of the parenchyma. Accordingly, in the appraisal of hepatic injury the surgeon is more likely to underestimate than to overestimate the seriousness of the condition, and unless biopsy is obtained, this potential error should be taken into consideration in the evaluation of the influence of hepatic disease on operative result. Pre-operative estimations of hepatic function, based on retention of bromsulphthalein, have been carried out in only thirty-two cases of splenic anemia. It may be significant that the patient in this small series who died, belonged to a group of fifteen whose hepatic functional activity was believed to be impaired. As these tests have been employed only in recent years, sufficient time has not elapsed to permit a determination of their value in prognosis with regard to later results.

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In Table 2 (see chart) the results of the operation have been tabulated according to the gross condition of the liver as observed by the surgeon at operation. If the cases in which the condition of the liver was not mentioned are grouped with those in which the hepatic condition was classified as normal, and all others are considered as cases in which there was more or less hepatic injury, and the results of the two groups compared, it will be seen that the secondary affection of the liver had an appreciable effect on the early results and apparently only a slight influence on later results. The

Table 2

### Splenectomy for splenic anemia

Condition of liver as noted by surgeon  
at operation

Condition	Cases	Hospital mortality	Subsequent deaths	Living	Well	Fair	Poor	Not traced
Hepatitis	4		2	2		2		
Cirrhotic	62	6	26	28	21	4	3	2
Enlarged	15	3	7	5	3	1	1	
Congested	2	1	1					
Enlarged and congested	1	1						
Thick, not large	1			1	1			
Adherent	6		3	3	2		1	
Atrophic	6		1	5	4	1		
Hard	2		2					
Normal	42	3	14	24	23	1		1
Not mentioned	26	2	12	12	9	2	1	
Total	167	16	68	80	63	11	6	3

operative mortality was 7 per cent in the former group, as compared with 11 per cent in the latter, whereas the proportion of patients who are now living is 57 per cent in the former, and 50 per cent in the latter.

The sixty-two cases in which cirrhosis of the liver was present at operation form an interesting group. Of the forty-six patients who survived the operation twenty-eight (50 per cent) are alive. This not only furnishes proof of the wisdom of accepting for operation patients with advanced Banti's disease, but indicates the remarkable power of the liver to regenerate following removal of the diseased spleen. As pointed out by W. J. Mayo,

removal of the spleen in this disease greatly lightens the load which has been thrown on the liver by reducing, by at least 20 per cent the volume of blood entering the portal circulation, by removing possible toxic substances originating in the spleen, and by producing adhesions for the establishment of collateral circulation

In spite of the most gratifying benefit derived from the operation, even in many of the advanced cases, as evidenced by the improvement of the blood and of general health, and by prolongation of life, the recurrence of gastro-intestinal hæmorrhages in a large group of these cases presents a discouraging problem. In approximately 50 per cent of the ninety-eight cases in which there was gastro-intestinal hæmorrhage before operation, there has been one hæmorrhage or more subsequent to splenectomy. Since the hæmorrhage commonly results from rupture of greatly dilated varices situated beneath the mucous membrane of the lower end of the œsophagus, it has been suggested that this complication might possibly be minimized by tying the coronary vein, with the view of reducing the enormous turgescence by breaking communication with the portal circulation. In the hope of promoting additional collateral circulation, which is, in fact, nature's means of combating portal obstruction, it would seem that some form of omentopexy is indicated in selected cases as a measure supplementary to splenectomy. Because inclusion of a segment of the omentum in closure of the wound jeopardizes healing, I prefer to incorporate it in the abdominal wall, lateral to the incision for laparotomy. After separation of the several layers of the abdominal wall for 3 centimetres from the edge of the wound, a small incision is made through the peritoneum and posterior sheath of the rectus abdominis muscle, and a segment of omentum 14 to 20 centimetres is then drawn up through this opening and sutured. Similar incisions are made in the muscle and anterior sheath of the rectus abdominis, at successive levels, each lower than the preceding one, 2.5 centimetres or more apart, and the omentum is drawn through these, the distal 5 to 8 centimetres is then buried beneath the skin.

By bringing the omentum out in a steplike manner, conditions are established for the formation of new blood channels in each layer of the abdominal wall, and on account of the oblique course of the openings, the chances of troublesome herniation are minimized (Fig 1.)

One or both of these procedures, ligation of the coronary vein and omentopexy, have been employed in conjunction with splenectomy in thirteen of the cases seen more recently, but there has not yet been sufficient time to permit estimation of their value in the prevention of recurrent hæmorrhages.

*Hæmolytic jaundice*—This condition may be defined as hæmolytic disease affecting primarily the spleen and secondarily the liver, characterized by varying degrees of anæmia, by acholuric jaundice, that is, jaundice with unaltered stools and urine, splenomegaly, microcytosis, and increased fragility with active regeneration of the erythrocytes. Two types of the disease have been described, the congenital and the acquired, distinguished chiefly

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by differences in the age of onset and the severity of the course of the disease. However, Giffin seriously questions whether many of the cases of the acquired type reported in the literature, should, in the absence of characteristic changes in the blood, be rightfully included as cases of hæmolytic jaundice. Regardless of the age at which the prominent features of the disease become manifest, he believes that all the cases of the series reported herewith were probably fundamentally congenital in origin.

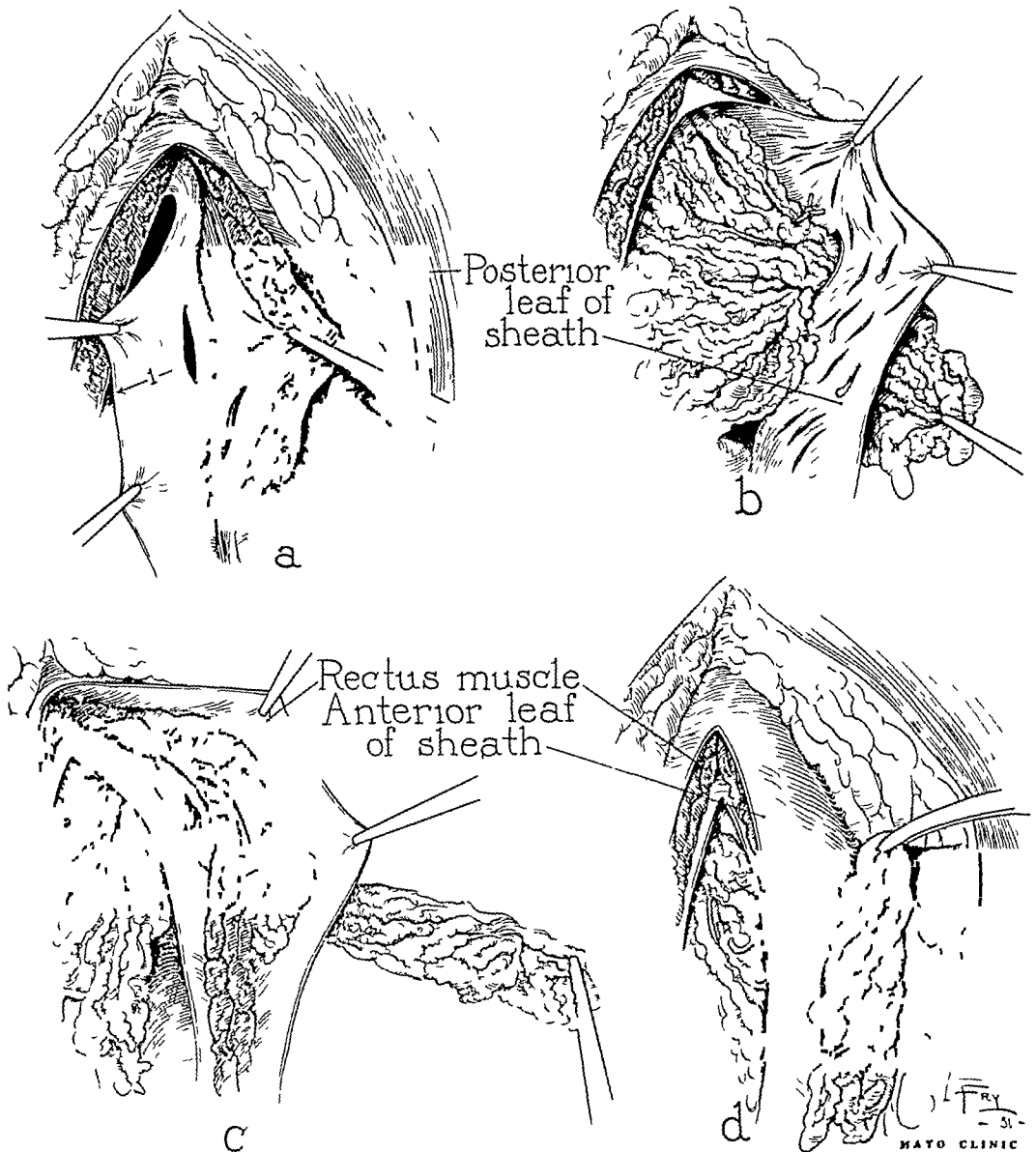


FIG 1—Stages of the operation for omentopexy

Between June 30, 1911, and January 1, 1931, 118 patients with hæmolytic jaundice were subjected to splenectomy at The Mayo Clinic (Table 3). Four of the patients died in the hospital (3.4 per cent). There was considerable variation in the course of the disease. Among children, and adolescent patients, it was for the most part continuously mild and chronic, the health of the patient apparently was little affected. In other cases the chronic course

was interrupted by one or more attacks of "crisis," characterized by malaise abdominal pain, fever, increase in size of the spleen, deepening of the jaundice, and increase in anæmia. Not uncommonly, the crisis is mistaken for biliary colic, and operation is advised. Conclusive evidence of disease of the gall-bladder, with and without stones, occurred as a secondary complication in eighty-one cases (68.6 per cent of the series) and in twenty-three of these, operations on the biliary tract had been performed elsewhere, presumably without knowledge of the presence of the primary disease. In none of these cases were gall-stones found in the common bile-duct, although in several cases a direct van den Bergh reaction was obtained.

Operative data were suggestive of secondary affections of the liver in fifty-five cases. Cirrhosis of the liver was noted by the surgeon in seven cases, and in six cases ascites was found, but the condition of the liver was

Table 3

Splenectomy for hemolytic jaundice

Age by decades	Cases	Hospital mortality	Subsequent deaths	Living	Well	Fair	Poor
0 - 9	21		2	19	16	3	
10 - 19	20		2	17	13	4	
20 - 29	38	2	2	32	28	2	2
30 - 39	24	1	4	18	15	1	2
40 - 49	11		1	9	8	1	
50 - 59	4	1		3	2	1	
Total	118	4	11	98	82	12	4

not mentioned. In the remaining thirty-two cases, the liver was described as enlarged, congested, hard, or adherent.

On comparing the results of the operation in these cases with the results in cases in which the liver was normal or was presumed to be normal it would seem that the secondary affection of the liver exerted a decisive influence. The operative mortality was 5.4 per cent in the former group, as compared to 1.6 per cent in the latter, whereas the proportion of patients who survived the operation and who are living, is 80 per cent in the former group, and 90 per cent in the latter.

Evidence of the benefits of splenectomy usually becomes apparent within five or eight days after the operation, the jaundice then begins to fade and it disappears completely within two or three weeks. In many instances the patient is now free of jaundice for the first time in his life. Rapid and progressive improvement of the anæmia is also commonly noted before the patient is dismissed from the hospital. However, certain of the most char-

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acteristic changes in the blood, such as microcytosis and increased fragility of erythrocytes, usually do not disappear after removal of the spleen

The late results are equally gratifying. Approximately 86 per cent of the patients who recovered from the operation are living, and 83 per cent of these are in good health. Of the eleven patients who died subsequent to recovery from splenectomy, the cause of death of six was not attributable to the effect of the operation or the disease. The remaining four died of conditions probably secondary to the hæmolytic jaundice, such as cirrhosis of the liver, gastro-intestinal hæmorrhage, and severe anæmia.

In view of the low operative hazard, and the exceedingly satisfactory results of surgical procedures, and considering the high incidence of hepatic and biliary complications in the untreated cases, I believe that splenectomy should be advised as the safest method of treatment in all cases of hæmolytic

Table 4

### Splenectomy for hemorrhagic purpura

Age by decades	Cases	Hospital mortality	Living	Well	Fair	Poor
0 - 9	7		7	6	1	
10 - 19	12		12	11	1	
20 - 29	14		14	13	1	
30 - 39	5	1	4	4		
40 - 49	2		2	2		
50 - 59	1	1				
Total	41	2	39	36	2	1

jaundice, certainly in the severe cases and in those in which there is a history of recurrent crisis.

*Hæmorrhagic purpura*.—From March 7, 1923, to January 1, 1931, splenectomy was performed for hæmorrhagic purpura in forty-one cases, with two deaths (Table 4).

Hæmorrhagic purpura is an idiopathic hæmorrhagic disease, characterized by hæmorrhage from the mucous membranes, petechiæ, varying degrees of secondary anæmia, diminution in the number of blood platelets, and usually slight enlargement of the spleen. It occurs in two forms, the acute and the chronic relapsing. It is essentially a disease of early life, although occasionally patients past middle life are affected. In this series only three patients were aged forty years or more. The incidence was twice as great in females as in males. Crops of petechiæ and hæmorrhages from the mucous membranes were often the only prominent clinical features of the disease. The bleeding varied in severity from slight oozing usually from the gums

nose and uterus, to intractable hæmorrhages. One patient died as a result of cerebral bleeding.

The typical changes in the blood in these cases were (1) Reduction in the number of platelets, (2) prolonged bleeding time, (3) delayed retraction of the clot, (4) normal coagulation time, and (5) secondary anæmia with evidence of the normal regeneration of the erythrocytes. The capillary resistance test, indicating abnormal permeability of the capillaries, was positive in all cases in which it was employed.

Since the principal indication for splenectomy in hæmorrhagic purpura is a definite diagnosis, it is extremely important to distinguish this disease from others in which hæmorrhagic tendencies are common, notably, aplastic anæmia, hæmophilia, and acute leucemia. This usually can be readily accomplished by correlating the results of detailed examination of the blood with the clinical history. However, the diagnosis may at times be extremely difficult, and failure of an accurate diagnosis undoubtedly accounts for many of the poor results reported in the literature.

In but few diseases in which symptoms are so alarming are the beneficial results of operation so dramatic as in hæmorrhagic purpura treated by splenectomy. It occasionally happens that the patient is bleeding at the time of operation, and sometimes the hæmorrhage ceases before the patient is returned to his room.

An appreciable rise in the number of the blood platelets has been noted within twenty-four hours after removal of the spleen, and often by the third day the platelet count is within normal range. The thirty-nine patients who survived the operation are alive, and all but three are in good health. Giffin observed, in some cases, mild recurrence of hæmorrhage, which ceased following elimination of infected tonsils or teeth.

#### CONCLUSIONS

From these data it is evident that, contrary to the prevalent view of the hazardous nature of splenectomy, the operative results (67 per cent) compare favorably with those of other major abdominal operations, and in spite of the relatively common mistakes made in diagnosis, the conditions associated with disorders of the spleen and amenable to splenectomy can readily be identified, provided complete data concerning the blood are correlated with the clinical history.

Since the operative results in cases of splenic anæmia are largely contingent on the presence of secondary affections of the liver and portal obstruction, the need for early diagnosis and operation is apparent. Enlarged spleens, in the absence of definite etiology, should be considered as instances of the splenomegaly of potential splenic anæmia, and operation should be advised. However, clinical evidence of the presence of hepatic injury should not in itself be considered a contra-indication to splenectomy, since many patients in this group lived active lives for many years after removal of the

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spleen The relative frequency of recurrent hæmorrhages in these cases indicates the need for additional effort toward their prevention, such as ligation of the coronary vein and omentopexy

In view of the high percentage of secondary affection of the liver, the small operative hazard, and the extremely favorable late results, splenectomy would seem to be the safest procedure in all cases of hæmolytic jaundice

Splenectomy for hæmorrhagic purpura is a comparatively safe procedure, and the benefits are lasting In the severe cases, delay of operation is fraught with danger

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# ABSCCESS OF THE LIVER

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FROM THE EMORY UNIVERSITY MEDICAL SCHOOL

ABSTRACTS are herewith submitted of nineteen cases of abscess of the liver treated in the Emory University division of the Grady (Municipal) Hospital, during the five-year period, 1926-1931. The first fourteen are cases caused by the *endamoeba histolytica*, while in the remaining five cases pyogenic bacteria are the etiologic agents. All the patients were native-born Georgia negroes, and only one patient with amoebic disease ever lived outside the state. The clinical history suggests malaria as a causative factor in several instances, but all the amoebic cases were negative for this plasmodium. More than 50 per cent of the patients entering this hospital give positive blood Wassermanns. It so happened that only two of these patients had syphilis. During the same five-year period, among approximately the same number of white patients admitted to the hospital, 25,000, there were two cases of amoebic hepatic abscess.

A review of the cases of amoebic abscess in the series invites comment concerning the clinical aspects. It has been shown repeatedly that amoebic dysentery and abscess are not diseases confined to the tropics. The term tropical abscess, meaning amoebic abscess, should be discarded. Amoebic abscess also is regarded as being single, and pyogenic abscess as being multiple. One of these patients had multiple amoebic abscess, two patients had single pyogenic abscess. Males are more susceptible to the disease than females, in a proportion of 5 to 1, and in the state of Georgia the colored race is considerably more susceptible than the white race. Most authors mention alcoholic addiction as a predisposing factor in the etiology of amoebic abscess. Only one patient among these fourteen used alcohol excessively.

Only five patients gave a history of bloody dysentery preceding or accompanying abscess formation, and in but one patient could the amoeba be demonstrated in the stool. The *endamoeba histolytica*, or its encysted form, was recovered from the pus or the abscess wall in eleven of fourteen patients. The three other patients present such typical clinical findings of amoebic abscess that the diagnosis seems warranted. Sometimes amoebæ may be found in the first escape of fluid from the abscess cavity, or by scraping the abscess wall. Again they may not appear in the discharge until the second or third day after operation. In none of these patients was jaundice present although jaundice is not easily discernible in the black race.

Amoebic abscess of the liver is divided into the acute and the chronic form. There are typical examples of both kinds in the series, but three cases are described which might be placed in a third classification, the sub-

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acute The symptoms are not so rapidly overwhelming as in the acute form, and yet do not spread over such a long period of inactivity as in the chronic variety In acute abscess the onset is sudden, with severe abdominal pain, which appears to be worse at night There are chills, high fever and extreme prostration Then follows the rather sudden appearance of a large tender mass in the right upper quadrant Bloody dysentery may or may not precede or accompany the other manifestations Vomiting and other



FIG. 1.—Amebic abscess of liver

gastro-intestinal symptoms may be present, suggesting the existence of perforated gastric ulcer, with subphrenic abscess formation The disease may terminate fatally in a few days Instances have been mentioned in which liver abscess has perforated into the stomach, or through the diaphragm into the pleura or a bronchus No such cases were observed in this group

The chronic variety may exist for many years, with alternating appearance and subsidence of symptoms from time to time The prognosis is good There are apt to be cough, night sweats and weakness and tuberculosis is

suspected The cough may be due to the pressure of the elevated liver against the diaphragm Harrington<sup>1</sup> reports five cases of amœbic hepatic abscess, in four of which the lesion was first diagnosed as thoracic rather than abdominal Two of the patients in the present group were operated upon twice for amœbic abscess, occurring in different parts of the liver at widely separated times

Rogers, (2), in his classical monograph on amœbic abscess, calls attention to the presence of the relatively low percentage of polymorphonuclear leucocytes This probably is true in the chronic form, in which only amœbæ are causative factors Although demonstrated bacteriologically in only two of these cases, in which staphylococci were found, it appears that acute abscess generally means mixed infection, and both the total leucocyte count and the percentage of polymorphonuclears are high

Rontgen examination of suspected hepatic abscess cases is not consistently helpful in the diagnosis The demonstration of an elevated diaphragm is valuable information, but sometimes it seems difficult to determine whether the pathology is below or above the diaphragm Several of these cases are reported as showing pleural or pulmonary lesions, as in Harrington's experience LeWald's<sup>3</sup> recommendation offers a solution of the problem A lateral thoracic rontgenogram always should be taken It brings out the complete curve of the diaphragm, and seldom fails to differentiate between disease below and above the muscle In some cases such pathologic conditions may coexist The aspiration of a liver abscess, and replacement of the fluid with lipiodol, furnishes a graphic rontgenogram of the abscess cavity One case in the series presented on percussion a large area of resonance just above the liver This was puzzling until the rontgenogram disclosed a collection of gas produced by a gas-forming organism from a ruptured hepatic abscess

The diagnosis of amœbic liver abscess would be made easier if the amœba could be found in the stools in more cases The history, symptoms and signs are variable, and often prolonged study of patients is necessary One sign always is present, if it can be established—an enlarged liver The problem then is to eliminate syphilis, malignant disease, cirrhosis and other causes of enlarged liver

Rogers protests against open operation in amœbic hepatic abscess, which he claims invites secondary infection and greatly increases the mortality He urges treatment by repeated aspiration This method may be indicated in abscess due solely to the *endamoeba histolytica*, if one can locate the involved area without exposing the liver In the majority of cases in this group, however, in which mixed infection was presumed to be present already, more radical and more certain surgical incision and drainage seemed to be the method of choice Usually the procedure should be carried out in two stages, as in operating upon lung abscess If this rule had been followed consistently in the present series, probably two deaths would have been avoided Since an amœbic dysentery the adequate administration of emetine

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hydrochloride is said to prevent the development of liver abscess, the continuation of the drug, in one-gram doses daily, given hypodermically, furnishes logical preparation for operation. Solutions made from quinine, emetine, amodin, *etc*, were used in irrigation after operation, but their value was not determined.

Five cases are classed as acute amœbic abscess, six cases as chronic, and three as subacute. The abscess was located in the right lobe invariably. In six patients the approach to the liver was through the muscular abdominal wall, and in six the liver was reached through rib resection. The abscess area was easily recognized. The pleura was incised in three patients, once accidentally, with a fatal outcome. Two stages were employed in three cases. In the first stage the liver was sutured to the abdominal or chest

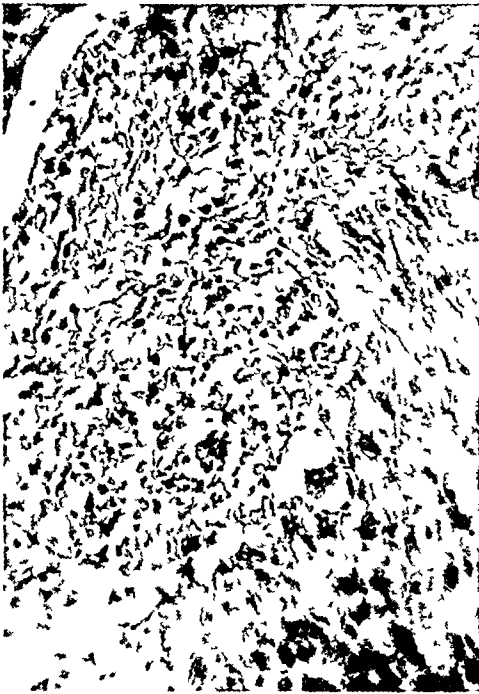


FIG 2

FIG 2—Amœbic abscess of liver, high power microphotograph showing wall of abscess with healing process



FIG 3

FIG 3—Amœbic abscess of liver, low power microphotograph showing necrosis of margin of abscess. Blood vessel filled with white corpuscles

wound, or the wound packed so as to isolate an area for opening the abscess twenty-four hours later. Local anæsthesia was the usual preference. Five deaths occurred among the amœbic cases, a mortality of 35.7 per cent.

There were two recoveries among the five patients with liver abscess due to pyogenic organisms. One abscess was caused by a stab-wound of the liver, and the other followed a gunshot-wound. Both were single abscesses, streptococci and colon *bacilli* being found in the abscess due to the stab-wound, and the colon *bacillus* alone being recovered from the abscess due to the gunshot-wound. Of the three patients who died, no history could be obtained in two. The third patient developed liver abscess from a

splenectomy performed two months previously for splenomegaly due to splenitis. These three abscesses were multiple, the colon *bacillus* being present in one case, and the streptococcus in the other two cases. Differential pre-operative diagnosis between liver abscess due to amœbæ and abscess caused by pyogenic bacteria, with negative stools, is rarely made, except in traumatic cases. Certainly, the prognosis is far less favorable in multiple abscess than in single abscess.

### CASE REPORTS

CASE I—Male, aged forty-two. Admitted October 27, 1926. Four months before admission, the patient first noticed pain in the upper abdomen, which was followed in a few days by the rather sudden appearance of a mass in the region of the liver. At about the same time bloody dysentery appeared. He was weak, and apparently had lost considerable weight. The liver, or a mass continuous with the liver, extended to within 2 centimetres of the umbilicus. The mass was smooth, round and pulsating, but it was not expansile, and no bruit could be heard. It felt cystic rather than solid. Rectal examination showed marked redness of the mucosa, but no ulceration. Röntgen study reported deformity of the duodenum, due to pressure, and 4 centimetres' elevation of the right side of the diaphragm. Temperature 103°, pulse 85. Leucocytes 20,400, polymorphonuclears 62 per cent. The stools were found loaded with *endamoeba histolytica*. The examination otherwise was essentially negative. The diagnosis was amœbic abscess of the liver. Following the hypodermic administration of emetine hydrochloride gram 1 daily for three days, on November 5, under local anæsthesia, through a right rectus incision, a single cavity in the right hepatic lobe was emptied of 750 cubic centimetres chocolate-colored, odorless fluid characteristic of amœbic abscess, and tube drainage instituted. Amœbæ were not demonstrated in this fluid, the abscess wall was not scraped. Three days later amœbæ were found in the discharging pus. Alcresta tablets of ipecac were given the patient after the operation. January 7, 1927, the patient was sent home with normal temperature, and only a small drain in the wound. Three days afterwards he returned on account of fever, and swelling in the line of the incision. This was reopened, with further discharge of pus from the liver cavity. February 1, he was dismissed as cured. In May, 1931, he was readmitted to the hospital with the development of another amœbic abscess in a different portion of the right hepatic lobe. The patient was not very sick this time. The abscess was drained through resection of the ninth rib in the mid-axillary line. Amœbæ were demonstrated in the pus. The patient left the hospital in three weeks in good condition, returning to the out-patient clinic to be dressed.

CASE II—Male, aged forty-two. December, 1926, first noticed that his abdomen was swollen, but did not seem to be very sick, and was able to continue with his work. He may have had diarrhœa before this time, but was not certain. February, 1927, he had headache and nausea, and grew very weak. There was pain in the chest, and dyspnœa, but no cough nor night sweats. When he entered the hospital, September 6, 1927, his liver could be felt 10.5 centimetres below the costal margin. Temperature was normal, and did not reach 100° all the time he was in the hospital. Leucocytes 12,250, polymorphonuclears 59 per cent. He had been a heavy drinker. The röntgen diagnosis was fluid in the right chest. September 8, an aspirating needle was introduced through the ninth interspace, thinking the pleural cavity was being reached. Instead, the withdrawal of 3,400 cubic centimetres of thick brown odorless fluid caused the abdominal distention to disappear. The swelling gradually recurred, however, and fifteen days later, under local anæsthesia, an abscess in the right lobe of the liver was drained in one sitting, by resecting the ninth and tenth ribs. Three days later the encysted form of the *endamoeba histolytica* was found in the pus. The patient was dismissed, November 2, as cured.

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CASE III—Female aged twenty In June, 1926, she had dysentery for three months, passing blood and mucus This subsided, but in August, 1927, recurred with increased severity At this time there were "slow aching" abdominal pains, which were worse at night One week before admission the pain took on the nature of cramps, accompanied by nausea and vomiting A large amount of brown sputum was expectorated She lost twenty pounds in weight, and was very weak Upon admission, September 27 1927, the patient was found to have a bulging in the right upper abdomen, extending 7.5 centimetres below the costal margin The mass was tender, and the right rectus muscle was rigid Temperature 103° pulse 110 Leucocytes 17,000, polymorphonuclears 58 per cent Wassermann four plus Patient not addicted to alcohol Rontgenogram showed an enlarged liver with elevation of the diaphragm 5 centimetres Repeated examination of stools failed to reveal either blood or amœbe, but the clinical diagnosis was

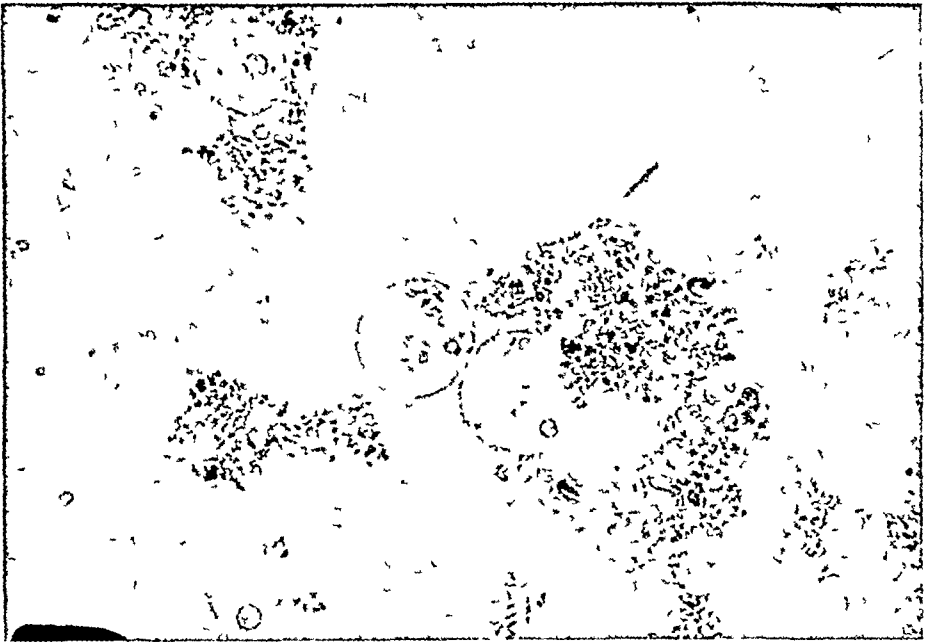


FIG 4—Microphotograph showing endamæbe histolytica from liver abscess Red blood corpuscles in amœbe

amœbic abscess of the liver The patient refused to have an operation, and signed a release October 2

CASE IV—Male, aged fifty Six months before admission the patient complained of soreness across the abdomen, and two weeks later noticed abdominal swelling Afterwards he had bloody mucus dysentery He entered the hospital June 2, 1928, and was found to have an enlarged liver, extending 7 centimetres below the costal border The mass was tight and smooth, and somewhat tender The stools contained mucus and blood but no amœbæ were seen The temperature was normal, leucocytes 4,360, polymorphonuclears 51 per cent June 3, under local anæsthesia, through a right rectus incision 250 cubic centimetres chocolate-colored fluid were evacuated from the right lobe of the liver, and tube drainage used June 6, staphylococcus in pure culture was obtained from the wound, and June 8, amœbæ The temperature rose to 100° immediately after the operation, but the next day was normal, and remained so The patient was given emetine hypodermically, and the wound irrigated with emetine 1 per cent He was dismissed five weeks after operation as well

CASE V—Female, aged twenty-nine This patient had been sick for four and a half years before she came to the hospital In August, 1924, she had recurrent severe attacks of pain in the right abdomen lasting for three weeks She had as many as ten or fifteen short paroxysms in twenty-four hours, mostly at night These pains sub-

sided, but returned in the same way in October, 1924, when she vomited frequently, and grew very weak. Again, she was comparatively well until September, 1926, when the pain appeared in the left side, but she thought the right upper abdomen was swollen. In January, 1928, she had dull aching in the epigastrium. She belched a great deal of gas, usually about two hours after eating. Upon entering the hospital, March 26, 1928, she had a mass reaching 10 centimetres below the costal margin. Temperature  $99.8^{\circ}$ , pulse 70, leucocytes 14,950, polymorphonuclears 63 per cent. Stools negative. The roentgenogram showed the right diaphragm elevated 8 centimetres. The roentgen diagnosis was tumor of the ovary or kidney. In a conference of the surgical staff, while most members thought the condition was liver abscess, the possibility of liver or pancreatic cyst or tumor was considered. April 11, under gas anaesthesia, through an abdominal incision, a hepatic abscess, with thick fibrous wall, was disclosed.



FIG 5



FIG 6

FIG 5—Liver abscess showing elevation of diaphragm  
FIG 6—Liver abscess injected with lipiodol outlining cavity in liver

in the right lobe, and 4,500 cubic centimetres chocolate-colored fluid removed. Encysted amœbæ were found in the pus. The patient died eight days after operation from peritonitis, with temperature  $107^{\circ}$ .

CASE VI—Male, aged twenty-six. This patient entered the hospital March 4, 1929, and died the next day without being fully studied. He gave a history of four weeks' illness, beginning with vomiting, colicky pains, daily chills, weakness and diarrhoea. Autopsy showed one large liver abscess, and several small ones. Amœbæ were recovered from the walls of the abscesses.

CASE VII—Male, aged thirty-six. Entered hospital November 12, 1929, with history of fullness in the epigastrium and shortness of breath for the preceding six months, getting progressively worse. He had epigastric pain which seemed to come one hour after meals, nausea and vomiting, and a productive cough, which did not show tubercle bacilli. The liver reached 8.5 centimetres below the costal margin. Temperature was  $101.4^{\circ}$ , pulse 100, leucocytes 9,500, polymorphonuclears, 74 per cent. Roentgenogram showed the right diaphragm 5 centimetres above normal. Gastro-intestinal

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series negative except for pressure deformity of the duodenum November 23, under local anæsthesia, tenth rib was resected, aspiration revealed no pus Then the ninth rib was resected, and the liver sutured to the wound During the last procedure the pleura was accidentally opened, and closed Four days later a large subphrenic abscess was opened, and characteristic amœbic fluid evacuated, but no amœbæ could be demonstrated The patient died on the table

CASE VIII—Male, aged twenty-six Sick eight weeks before admission, with pain in right side, hemoptysis and dyspnœa No dysentery On entering the hospital, December 26, 1929, the leucocytes were 10,200, polymorphonuclears 85 per cent, temperature 101.6°, pulse 100 Many pus-cells in the urine There was a mass in the right side, diagnosed as pyelonephritis, polycystic kidney, etc Fluoroscopy showed the right diaphragm raised to the third rib January 1, 1930, under novocaine, a large abscess in the right lobe of the liver was evacuated, positive for amœbæ The patient ran a septic course and died January 12

CASE IX—Male, aged thirty-six Patient stated that nine years before admission, December 27, 1929, he had bloody dysentery, and was operated upon for a liver abscess Nine months before admission he had another attack of dysentery, which subsided Six months later the present trouble started with pain in the right upper quadrant and dyspnœa The liver was enlarged and very tender Temperature 101.3°, pulse 90, leucocytes 12,100, polymorphonuclears 78 per cent The fluoroscope suggested fluid in the right chest January 1, 1930, under gas anæsthesia, a large amount of chocolate-colored pus was removed from the liver through an abdominal incision The temperature dropped to normal, and remained so No amœbæ were found, but the history and clinical findings were those of amœbic hepatic abscess The patient left the hospital February 14, marked as improved

CASE X—Male, aged thirty-six Admitted September 15, 1930 For many years the patient drank a pint of whiskey daily One month before entering the hospital, while lifting a heavy sack of meat, he felt a sudden sharp pain in the epigastrium, which caused him to quit work for the day He was able to work as usual until September 2, when he had a recurrence of the attack, more marked, compelling him to seek his bed September 6, he had a severe chill The pain grew worse, and was accompanied by vomiting On admission his pulse was 86, temperature 100.4°, respiration 22 A few hours later he had a chill, followed by temperature 103.6°, leucocytes 18,250, polymorphonuclears 80 per cent Urine negative Wassermann three plus There was a firm rounded mass in the liver region, extending 13 centimetres below the costal margin The mass was somewhat tender, and there was no expansile pulsation nor bruit There was no history of dysentery, but there was occult blood in the stools Rontgenogram showed normal lungs, with the right diaphragm elevated 5 centimetres The mass apparently increased in size, and on September 23, under local anæsthesia, through a right rectus incision, 600 cubic centimetres chocolate-colored fluid were removed, and the cavity drained This fluid was negative for amœbæ, but four days later amœbæ were found in the draining pus The patient had a normal convalescence, and was dismissed November 2 as cured

CASE XI—Male, aged thirty-six Three months before admission the patient complained of a dull aching pain in the right upper quadrant, mostly at night This continued for three weeks, when he grew so weak he had to quit work He then began having night sweats, but no bloody dysentery He lost weight, and developed pain in the right shoulder Later the pain was felt in the chest, and he began to cough On entering the hospital, April 19, 1930, his right lung was flat at the base, and a friction sound was present over the area The liver dullness apparently was not increased below, but the liver was tender above, and the abdomen was somewhat rigid Temperature 103.3°, pulse 110, leucocytes 17,200, polymorphonuclears 88 per cent Sputum negative The fluoroscope revealed elevation of the right diaphragm April 19, under local



inesthesia first-stage thoractomy performed April 22, second stage, with evacuation of typical amœbic fluid April 24 amœba found in discharging pus May 21, patient sent home as cured

CASE XII—Male, aged nineteen Sickness started January, 1930, with pain in upper abdomen fever night sweats, prostration, no chills Admitted May 20, with temperature 100°, pulse 140, leucocytes 15,000, polymorphonuclears 81 per cent The liver was tender, 9 centimetres below costal border No history of dysentery, stools negative Rontgen report was right diaphragm high Diagnosis—Amœbic abscess of liver May 27, under local anæsthetic, pleura sutured to diaphragm through the ninth rib May 28, abscess in right lobe of liver emptied of 500 cubic centimetres chocolate-colored fluid Numerous amœbic cysts disclosed The patient's pulse and temperature dropped to normal a few days after the operation, and remained normal June 20 discharged as well

CASE XIII—Male, aged thirty-eight Patient came to hospital October 6, 1930, apparently very ill, temperature 101°, pulse 120 The liver was very tender, and the liver dullness greatly increased, extending 10 centimetres below the costal margin The patient's sickness began suddenly three weeks before admission, with pain in the right shoulder, no nausea or dysentery The diagnosis was liver abscess No rontgen work or blood counts were done prior to the operation, which was performed twenty-four hours after he entered the hospital Under novocaine anesthesia, through excision of segments of the eleventh and twelfth ribs, an enormous ruptured hepatic abscess was found, containing thick, brownish-yellow pus, with foul odor Ample drainage was provided The cystic form of the amœba was found a few days later Following operation the patient ran a septic course, with leucocytes varying from 15 000 to 32,000, and the polymorphonuclears from 79 per cent to 94 per cent November 20, rontgen examination following lipiodol injection into sinus, showed abscess cavity in liver December 21, the patient left the hospital as improved

CASE XIV—Female, aged seventeen She entered the hospital April 9, 1931, with a history of three weeks' illness marked by high fever and bloody dysentery The abdomen was very tender, rigid and bulging, the liver reaching 7 centimetres below the costal rim Pulse 140, temperature 102°-104°, leucocytes 24,000, polymorphonuclears 85 per cent, erythrocytes 1,150,000, hæmoglobin 35 per cent She had night sweats, nausea and vomiting The rontgen diagnosis was diaphragmatic pleurisy, the right diaphragm being elevated Wassermann three plus Bloody stools negative for amœbe April 15, under novocaine anesthesia, through a right rectus incision, 750 cubic centimetres foul, greenish-yellow pus were obtained from liver abscess Amœbæ were demonstrated The patient continued very sick, developed left lower lobar pneumonia, and died April 18

CASE XV—Male, aged twenty-five Patient entered the hospital December 7, 1927, in a delirious condition Impossible to obtain history Temperature 102°, pulse 130 Died the next day Autopsy showed multiple abscesses of the liver, *B. coli* present

CASE XVI—Male, aged thirty-nine Patient had chills and fever in Jamaica in boyhood In January, 1915, he had severe cramping pain in left upper abdomen, which lasted one year, and later recurred Two days before admission, May 27, 1928, he experienced another pronounced attack There was a tumor mass in the left upper abdomen, diagnosed as enlarged spleen or kidney Malarial parasites could not be demonstrated in the blood Temperature 103°, which dropped to normal after operation Wassermann negative May 22 splenectomy was performed under gas-ether anesthesia The spleen weighed 1350 grams and measured 10 by 20 centimetres The diagnosis was splenomegaly due to splenitis The wound became infected, the patient ran considerable temperature, but apparently got well and left the hospital June 19, with a small draining sinus July 2, 1928, the patient was readmitted with dyspnoea, swollen feet and liver extending 5 centimetres below the costal border The temperature was 101°, then became subnormal Hepatic abscess was diagnosed, but aspiration

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was negative. Blood culture showed streptococcus pyogenes. Death, July 30. Autopsy revealed multiple abscesses of the liver.

CASE XVII—Female, aged twenty-one. Entered hospital March 7, 1930, with history of being sick since February 21, with headache, followed soon by severe subcostal pain on the left side. A short time afterwards the pain enveloped the entire epigastrium, being boring in character. There were no chills or cough. The abdomen was slightly distended, rigid, did not move on respiration, and was markedly hypersensitive. There was no dysentery. An indefinite mass was made out in the abdomen. Temperature 103°, pulse 136, leucocytes 12,900, polymorphonuclears 80 per cent. The patient died three days after admission. Autopsy report was multiple liver abscesses from which streptococci were grown.

CASE XVIII—Male, aged twenty-seven. Entered hospital August 27, 1930, with history of stab-wound of right chest four weeks previously, for which he did not receive hospital treatment. Two days before coming to the hospital he complained of pain in the right upper abdomen, dyspnoea, cough and chills. Temperature 104°, pulse 120, respiration 22. Liver tender, and area of dullness somewhat increased. Röntgen investigation pointed to pus above the diaphragm. After several unsuccessful attempts to find pus by aspiration, three days after admission, under local anaesthesia, 200 cubic centimetres foul yellow pus were evacuated from cavity in the right lobe of the liver, through the ninth rib, in a two-stage operation. The bacteriological report was streptococcus and *B. coli*. It was necessary to reopen the abscess twice afterwards, but March 6, 1931, the patient finally was discharged as well.

CASE XIX—Male, aged twenty-seven. Entered the hospital November 16, 1930, having been admitted one month previously for multiple gunshot-wounds, involving the chest, abdominal wall, penis and scrotum. He had no operation for this trouble, and was discharged as well three weeks later. Four weeks before present admission he had sharp pain in the right side, which soon spread over the whole right abdomen. The abdomen was rigid and tender, and apparently a liver mass was present, extending 7 centimetres below the costal rim. Temperature 101°, pulse 100, leucocytes 18,000, polymorphonuclears 76 per cent. Stools negative. No Wassermann was made. November 18, under gas-novocaine anaesthesia, through right rectus incision, 300 cubic centimetres foul pus were removed from a cavity in the right lobe of the liver. *B. coli* was reported. December 15 patient was discharged as well.

## REFERENCES

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- <sup>2</sup> Rogers L. Amœbic Liver Abscess. Its Pathology Prevention and Cure. Lancet, vol. 1, pp. 463, 569, 677, March 11, 18, 25, 1922.
- <sup>3</sup> LeWald's Discussion of Harrington's Paper. Quoted above.

# THE SELECTIVE SURGICAL TREATMENT OF DIAPHRAGMATIC HERNIA

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DIAPHRAGMATIC hernia is a protrusion of abdominal contents through an abnormal opening in the diaphragm which results from imperfect development, anatomic weakness or trauma. Of 1,003 cases reported in the literature since 1900, nearly one-third were classed as congenital, a little more than one-third as acquired after birth, and about one-third followed trauma. Most of those of the acquired type were oesophageal hiatus herniæ.\*

In each of these etiologic types there are many anatomic and clinical variations which are of much importance to treatment. The presence or absence of a sac, the position and size of the ring, and the varying hernial contents constitute important anatomic differences. The strangulated and non-strangulated hernias represent the most definite clinical types, but lesser disturbance of physiologic function, age and general condition of the patient are important factors bearing on indications for surgical treatment and on the choice of operative procedure.

As reported in the literature, a sac is present in less than a quarter of the cases of congenital hernias, in more than 95 per cent of those acquired after birth, but is rarely present in hernias due to penetrating injury or violent blunt trauma. If a sac is present and is not incised pneumothorax does not result if the hernia is repaired through a laparotomy approach. On the contrary, if there is no sac, a pneumothorax develops through a laparotomy as well as through a thoracotomy approach.

If a congenital hernia is small the opening is most often posterior, if larger it is usually postero-lateral, if very large a sickle-like segment of the diaphragm may be found antero-laterally or there may be complete absence of the hemi-diaphragm. The predominatingly posterior location of a small opening is due to the fact that it is the site of the pleuro-peritoneal canal which is closed last by the developing diaphragm. A congenital hernia therefore typically involves the posterior portion of the diaphragm which is least accessible by a laparotomy. The opening may be too large for closure except by the aid of a plastic. In case of a sub-total or total defect a collapse of the chest wall may be a necessary preliminary operation.

Acquired hernias develop chiefly at the oesophageal hiatus, of which more than two hundred cases diagnosed roentgenologically, are reported in the recent literature. The hernia opening as a rule is small, easily approached and identified by thoracotomy but not infrequently is very difficult to expose

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\*For tables and complete bibliography see chapter on Diaphragmatic Hernia by author in Lewis' "Practice of Surgery," vol. 5, 1930.

## TREATMENT OF DIAPHRAGMATIC HERNIA

by laparotomy. The edges of the ring may be ill-defined and the œsophagus hard to identify.

There are about sixty reported cases of herniation through the parasternal foramina of Morgagni. Nearly all of them had a sac. More than half were on the right side. A hernia through one foramen may be into the opposite pleural cavity. These hernia openings lie directly under the xiphoid process and are therefore very easily approachable through a mid-epigastric incision, through which both foramina may be inspected and repaired. A thoracotomy approach, aside from the unnecessary hazard incident to a pneumothorax, necessitates transversing the anterior mediastinum in case the hernia is through the opposite foramen and does not allow inspection of other ring if the hernia sac is on the same side as ring. Therefore, hernias through the foramen of Morgagni should be repaired through a laparotomy exposure.

Traumatic hernias due to knife stab are usually small and situated peripherally or centrally. Those due to gunshot as a rule are small and may be in any portion of the diaphragm. Those caused by violent trauma are often quite large and variously situated. The muscle may be split widely and into the œsophageal hiatus, the attachment laterally may be extensively evulsed.

The content of diaphragmatic hernia varies largely with the size and position of the opening. Among 737 cases, there were seventy-two different combinations of part of the stomach, intestines, colon, omentum, spleen, liver, pancreas and kidney in the pleural cavity. A portion of the stomach alone was herniated in 20 per cent, the colon alone in 10 per cent, and the intestines alone in 3 per cent. The stomach was found in the hernia in association with other organs in 69 per cent, and the colon and intestines in combination with other organs in 71 per cent of the cases.

A small portion of the stomach is the characteristic content of an œsophageal hiatus hernia. It is not likely to become obstructed or strangulated. Operative repair is therefore less urgent. The transverse colon is usually found in the parasternal hernia, and it is often sufficiently constricted to produce obstipation, often of extreme grade. Operation is then urgently indicated. Small traumatic hernia openings are most apt to produce obstruction of a single acutely kinked loop of herniated bowel. Large congenital or traumatic openings usually result in herniation of a large portion of the abdominal viscera. There is often considerable embarrassment of respiration and circulation in such cases, and there is a likelihood of disturbance of function of the gastro-intestinal tract from partial obstruction. Kinking and volvulus may produce complete obstruction.

Among fifty-six cases of right-sided hernias, exclusive of those at the œsophageal hiatus, a part of the liver was the only viscus herniated in eleven, in eighteen of the others the hernia contents consisted of part of the liver in various combinations with stomach, colon and intestines. If liver is the only hernia contents, as judged by roentgenogram and absence of symptoms referable to herniation of stomach or bowel, there would seem to be

relatively slight indication for reduction or repair unless enough of the liver were herniated to interfere with respiration

Adhesions of the hernia contents are most apt to develop in the chronic traumatic type. Absence of adhesions can be determined clinically only if the hernia contents can be seen in and out of the pleural cavity roentgenologically

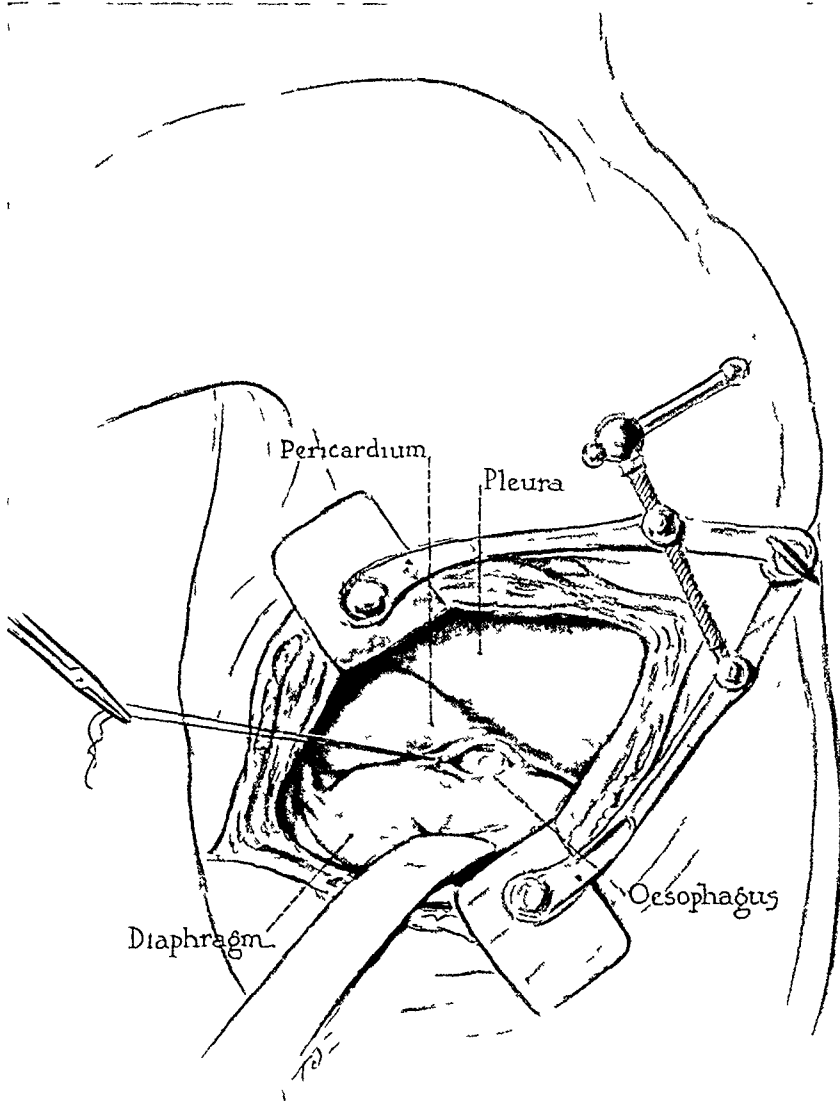


FIG. 1.—Seventh interspace thoracotomy approach to oesophageal hiatus

Herniation of a small part of the stomach through the oesophageal hiatus often can be produced by placing the patient in a horizontal or head-down position while under fluoroscopic examination. Such demonstration of a hernia is proof of the absence of adhesions.

Age is an important factor in consideration of treatment. Of 210 non-traumatic cases under one year of age, 158 (75 per cent) died before the

end of the first month after birth. All of these were necropsy cases. Since serious respiratory embarrassment is often associated with a hernia opening too large for direct closure, it follows that the outlook for saving many of these infants must be slight. However, some patients with complete absence of the diaphragm reach adult age and even advanced age.

The great majority of those of acquired origin are first recognized in the middle decades, some are well past middle life.

The proportion of cases that develop strangulation varies with etiologic type. Of 476 operated collected cases, including nineteen operated upon by the author, fifty-five were of congenital origin, of which 36.3 per cent were obstructed, sixty-four were acquired, of which 15.6 per cent were obstructed, 145 followed war injuries, of which 47.5 per cent were obstructed, 186 followed trauma incident to civilian life, mostly knife stab or blunt trauma, and of these 20.2 per cent were obstructed. These figures would seem to indicate, as one would expect, that hernias through small opening in the diaphragm, exclusive of œsophageal hiatus stomach herniations, are most prone to strangulation and therefore constitute as such, the stronger indication for immediate repair. Small knife-stab injuries, immediately repaired, lessen the incidence of civilian traumatic hernia obstruction.

The type and degree of interference with physiologic function constitute other clinical types that influence the indication for treatment. Dyspnoea and cyanosis with dextro-cardia occur particularly in infants and children with congenital hernias and at any age in presence of large traumatic hernias and may occur suddenly in any type after a large meal or following exertion. Such symptoms are urgent indications for surgical relief, but many of these patients die very suddenly before anything can be done.

Persistent vomiting or dysphagia with excessive weight loss and weakness make up a different clinical picture. Obstinate constipation with or without dyspnoea is often observed in cases of herniation of the colon through a small opening. Occasionally severe hæmatemesis or melæna with marked secondary anæmia are the striking findings. Many patients have a combination of the above-mentioned symptoms in milder degree but of sufficient severity to more or less incapacitate them.

On the basis of the foregoing it may be said that in the absence of definite contra-indications a small hernia anywhere, except at the œsophageal hiatus, should be repaired even in the absence of symptoms. A small hiatus hernia should be repaired if there are marked symptoms attributable to it. A large hernia anywhere constitutes in itself a relative indication for its surgical repair, and a definite indication if there are any marked symptoms such as described. On the same basis a small hiatus hernia not likely to become strangulated and giving rise to no definite symptoms, infancy and old age, and other conditions which materially increase the hazard of surgical treatment, constitute relative contra-indications to it.

The ideal surgical treatment is reduction and repair of the hernia open-

ing, but other procedures find their indications as emergency life-saving measures or as preliminary to repair

The most important emergency operation is drainage of an acute intestinal obstruction. This may be by a cæcostomy, appendecostomy, colo-colostomy or enterostomy, according to the individual indications. Truesdale

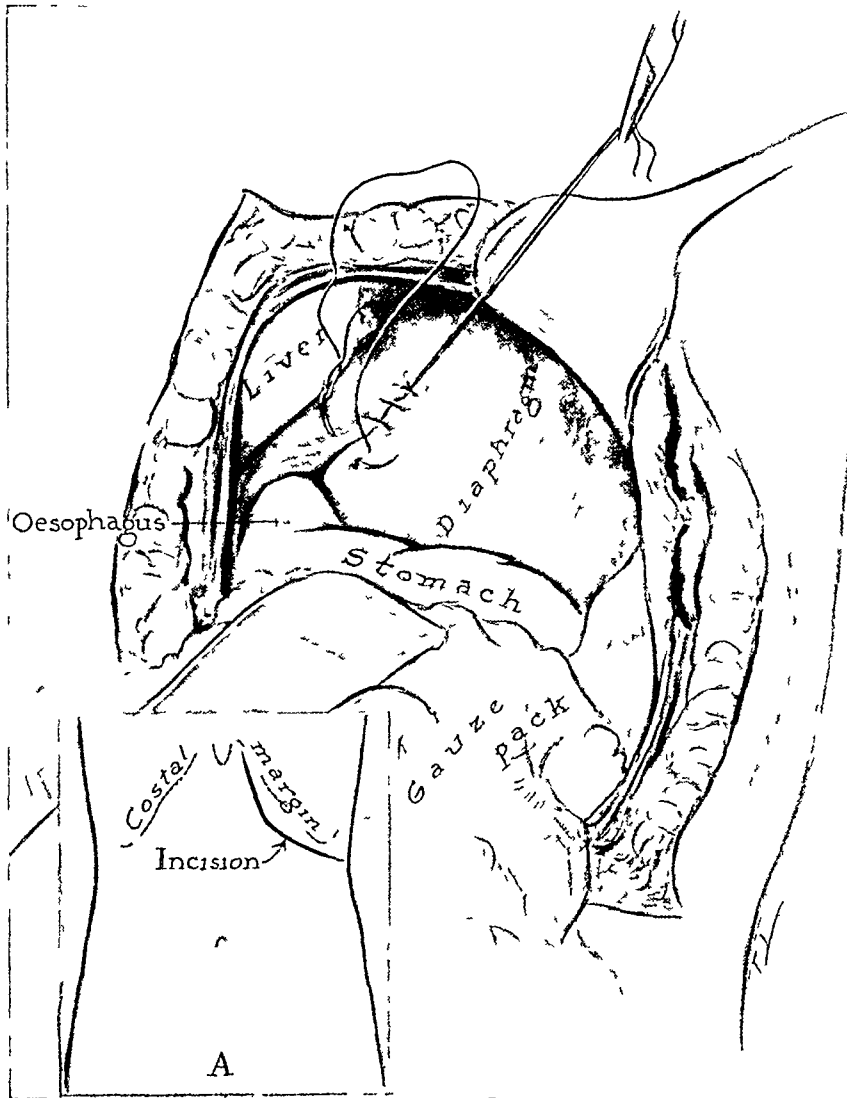


FIG 2—Left costal margin approach to oesophageal hiatus for repair of diaphragmatic hernia. The ligament of left lobe of liver has been cut and left lobe retracted for better exposure. Rectus muscle is split longitudinally to near the level of the umbilicus then sectioned transversely to avoid extensively damaging innervation.

has called attention to the value of dealing with an acute obstruction before attempting to repair the hernia. Several cases are reported in which all symptoms disappeared following colo-colostomy and no further treatment was necessary. If the bowel is gangrenous drainage at the site may avert a fatal issue.

Operations preliminary to closure of the hernia opening include phrenic nerve block, extra-pleural thoracoplasty and pneumothorax collapse. Of these operations the phrenic-nerve operation has by far the most important indications. The nerve may be frozen, crushed or extracted. If frozen or crushed there results complete paralysis of the diaphragm in perhaps 75 per cent of the cases, but a partial innervation remains in the other cases due to the collateral branches that enter the trunk below the level of the block. If, however, a thoracotomy is performed, the nerve may be blocked in its course on the pericardium, which produces a complete but temporary paralysis in all cases. Extraction of the nerve is naturally followed by complete and permanent paralysis.

The advantages of paralysis of the diaphragm are relaxation which facilitates closure of a large ring, and immobilization, which makes the operation technically easier, and also favors healing.

The operation is indicated in all cases of congenital hernias, in which the opening is often both large and relatively inaccessible, and in traumatic hernias due to blunt trauma. In acquired hernias at the œsophageal hiatus the opening is usually small and only half of the ring would be relaxed. Hernias at the parasternal foramen are usually relatively small and easily accessible. Furthermore, as stated, one cannot be sure before operation that the ring is on the same side as the sac and contents. In traumatic hernias due to blunt trauma the opening is often large, and in such cases the repair will be greatly facilitated by a relaxed diaphragm. In the repair of small openings due to penetrating injuries, paralysis of the diaphragm is unnecessary from the standpoint of relaxing the ring.

Ordinarily, a temporary, rather than a permanent paralysis is indicated. Only in cases in which the closure is effected under tension during a temporary block would it seem advisable to make the paralysis permanent by extracting the nerve.

Phrenic nerve block, or extraction, as an exclusive method of treatment of diaphragmatic hernia would seem equivalent in principle to simply enlarging a ventral or inguinal hernia opening in the treatment of these conditions.

Extra-pleural thoracoplasty, consisting of resection of the whole length of the lower ribs, finds its indications in cases in which the diaphragmatic defect is so large that its edges cannot be approximated. In 1925 I suggested such an operation. It has since been performed by Cairington and by Harrington. Bettman was able to close a congenital lateral hernia opening in an infant of three months following the relaxation obtained by simple section of the lower ribs.

In case of patients with total or subtotal defect there is little or no prospect of improvising an artificial partition between the pleural and peritoneal cavities. The symptoms are due chiefly to the prolapse of a large part of the abdominal viscera. In such cases a complete posterior and antero-lateral costectomy would result in practically a total obliteration of the pleural cavity.

Pneumothorax has been advocated as a preliminary to a thoracotomy.



approach for repair of a hernia. However, modern equipment for thoracic surgery includes positive pressure gas anaesthesia apparatus which largely obviates any danger from a wide open pneumothorax incident to a thoracotomy approach.

The repair of the hernia usually may be accomplished either through a laparotomy or a thoracotomy exposure. Occasionally both the pleural and peritoneal cavities must be opened to affect a reduction and repair. For this purpose separate incisions or a combined thoraco-laparotomy incision may be made. There exists considerable difference of opinion as to the relative merits of these various operative routes, as such.

The criteria on which they have been compared have been the relative technical difficulties and mortality rates.

There can be no doubt but that the identification of a hernia not previously diagnosed, and its reduction and repair is facilitated by a thoracotomy approach. Thus, in a series of 215 cases in which laparotomy was performed, the hernia opening was sutured in 129 (60 per cent), reduced but not sutured in thirty-seven (17.2 per cent), not reduced in thirty-three (15.3 per cent) and not found in sixteen (7.4 per cent).

Of 167 cases in which thoracotomy was performed, the opening was sutured in ninety-one (90 per cent), not sutured in six, not reduced in three and not found in seven. Of ninety-one cases in which combined thoraco-laparotomy was done the ring was sutured in eighty-one (87 per cent), not sutured in three and not found in seven.

According to figures usually cited the mortality rate following laparotomy is much higher than following thoracotomy, but this difference seems to be due to the relatively much larger proportion of obstructed cases operated by laparotomy. Of 467 cases 246 were operated by laparotomy with ninety-six deaths (39.9 per cent), 132 were operated by thoracotomy with twenty-six deaths (19.7 per cent), eighty-nine were operated by a combined laparotomy and thoracotomy and of these twenty-eight (31.4 per cent) died. Among these same 467 cases 149 were obstructed. Of these 100 were operated by laparotomy with sixty-nine deaths, twenty-three by thoracotomy with four deaths (17.3 per cent), twenty-six by a combination of both routes, with seven deaths (27 per cent). There were 318 non-obstructed cases. Of these 146 were operated by laparotomy with twenty-seven deaths (18.5 per cent), 109 by thoracotomy with twenty-two deaths (20.2 per cent), and sixty-three by the combined route with twenty-one deaths (33.3 per cent). It would seem probable that the patients with intestine obstruction who represented the poorest surgical risks were almost without exception subjected to a laparotomy. The increased mortality in these cases with perhaps a few exceptions would be due to the obstruction as such rather than to the operative route.

The uniformly high mortality rate following a combined thoracotomy and laparotomy is probably due in most cases to shock and an increased incidence of post-operative complications.

There exist definite indications for laparotomy and for thoracotomy regardless of technical considerations or any slight difference in mortality. A primary laparotomy is indicated in all cases of acute intestinal obstruction if there is doubt as to its cause. If the condition of the patient or the local findings are such that immediate reduction and repair is impossible, or too hazardous, the patient's best chances may lie in drainage of the bowel proximal to the obstruction as outlined above.

In case of a parasternal hernia a primary laparotomy is always indicated for reasons already mentioned. Only in case reduction from below is impossible after enlarging the ring would a secondary thoracotomy seem indicated.

Oesophageal hiatus hernias almost always have a sac. Closure by laparotomy therefore obviates a pneumothorax with the incident tendency to pleural effusion and empyema. The symptoms in case of a hiatus hernia may be due in part to other abdominal lesions such as a gall-bladder disease or peptic ulcer. Laparotomy approach makes possible exploration for such lesions. In case of thin individuals with short thoraces the hiatus is readily accessible by laparotomy.

Thoracotomy is the only approach to be considered in cases of fresh penetrating wounds of the thorax with prolapse of abdominal contents. The wound is enlarged as necessary for exposure, reduction and repair. If there is any probability of perforation or hæmorrhage from an abdominal viscus an incision may be made in the diaphragm for exploration and for adequate attention to such lesions, including splenectomy in case of extensive damage and bleeding of that organ. Thoracotomy is also indicated in chronic hernias with symptoms of partial obstruction, especially in case of chronic hernias due to penetrating injuries. In most cases the hernia ring is small and the herniated viscus is very frequently adherent to it, in which case splitting the diaphragm makes possible reduction without risk of tearing it. In obese patients and those with long narrow, rigid thorax, as in an older individual laparotomy approach to the hiatus may be exceedingly difficult. If there is much fatty deposit and coincident oozing it may be very hard to identify the edges of the hernia ring and the oesophagus. As a result, the closure may be inefficient, in which case the hernia is almost certain to recur. The ring may be closed too tightly if it cannot be clearly visualized. In one of my cases the closure was too tight and one suture penetrated the wall of the oesophagus leading to a fatal mediastinitis.

Aside from the considerations mentioned, the chief limitation of laparotomy is the difficulty or impossibility of reducing the hernia contents in case they are adherent to the inside of the thorax, and the greatest limitation to thoracotomy is the difficulty that may be encountered in reducing the viscera into the abdominal cavity. In case of a large hernia, present for a considerable time, the herniated abdominal viscera may have lost the "right of tenure" in the sense that there is no longer sufficient room for them in the abdominal cavity. Neither condition can be anticipated with certainty, but adhesions may be expected in case of spontaneously irreducible hernia of

long standing, especially of the traumatic type, and difficulty with reduction may be anticipated in obese patients and those with strong abdominal muscles as contrasted with the flabby abdomen of patients who have lost much weight, or in case of women who have borne many children

In case a laparotomy is the primary approach and reduction is impossible, or seems unsafe on account of adhesions, the abdominal wall may be closed temporarily and a secondary thoracotomy may then be performed. Or in case no difficulty with reposition of the viscera is anticipated the thoracotomy may be deferred to a later date. Similarly, in case a thoracotomy is first performed an immediate secondary laparotomy is indicated if there is serious difficulty with the reduction of the herniated viscera from above.

There can be no doubt that a combined thoraco-laparotomy facilitates exposure to the hernia opening, reduction and repair but, as stated, the mortality has been much higher than where the other routes have been used.

Special procedures, in cases with hernia openings that it has been impossible to close directly, besides plastic operations on the chest wall mentioned above as preliminary operations, include the use of muscle and fascia for direct repair and obturating the opening with an abdominal viscus. Keller has described a method involving the use of a portion of the latissimus dorsi muscle, Truesdale has used a fascial flap and Sauerbruch has sutured the diaphragm to the chest wall at a higher level than that of its normal attachment.

In case of a thoracic stomach in which only the cardiac portion of the viscus lay above the hiatus, it may be possible to transplant this portion of the stomach to the level of the diaphragm more laterally, as was done by Hybbinette. The opening has been obturated by suturing into it the adjoined portion of the stomach or spleen. In other cases an attempt has been made to prevent the stomach from herniating by suturing it to the abdominal peritoneum and to the diaphragm. Recurrences usually follow such methods. If the hernia opening is inaccessible by laparotomy a thoracotomy should be performed at the same time or later.

A simple procedure following reduction and repair of the hernia that may be life-saving is to reduce a surgical pneumothorax to a minimum. This may be accomplished by inflating the lung with the positive pressure gas anaesthesia apparatus before the pleural cavity is completely closed or afterwards by aspirating the air. The latter can be performed best with a pneumothorax apparatus by reversing the system, using the monometer as a guide in withdrawing enough air to produce a negative intra-pleural tension equivalent to 4 to 10 cubic centimetres of water pressure. This procedure relieves the mediastinum and so the other pleural cavity of the atmospheric pressure introduced by the pneumothorax. This, plus increased intra-abdominal pressure due to the restoration of herniated viscera into the abdominal cavity may reduce the vital capacity beyond the patient's power to compensate, and may also hamper circulation greatly. Re-inflation of the collapsed lung in itself increases respiratory capacity and lessens the hazard of a complicating post-operative empyema.

## TREATMENT OF DIAPHRAGMATIC HERNIA

Respiratory failure in infants, peritonitis from intestinal obstruction and post-operative shock are the most common causes of death among patients with diaphragmatic hernia

### SUMMARY

(1) The ideal treatment of diaphragmatic hernia is reduction of the hernial contents and repair of the ring. Practically, anatomic and clinical variations, age and general condition of the patient determine the indications for operation and largely the operative approach in each individual case

(2) Operative procedures consist of emergency life-saving measures, those preparatory to closure, and operations for reduction and repair

(3) Emergency measures are drainage of an obstructed bowel, or of a localized abscess, preparatory operations are phrenic nerve block or section and partial thoracoplasty

(4) Operation for repair may be through a laparotomy or thoracotomy approach or through a combination of both. In the majority of cases the hernia may be reduced and repaired by any one of these routes. There are special advantages, limitations and indications for each, depending on the anatomic and clinical type of hernia

(5) Special procedures for closure of large or recurrent hernias include muscle and fascia plastic operations, shifting the attachment of the diaphragm, and thoracoplasty in special cases

(6) Differential pressure anaesthesia is essential to obviate the dangers of open pneumothorax during operation, and inflation of the lung before closing the pleural cavity or aspirating the air later to restore the normal vital capacity of the opposite lung, and to reinflate the lung on the side of the hernia

(7) Respiratory insufficiency, especially in infants, intestinal obstruction and post-operative shock are the most common causes of death

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# LATE RESULTS OF SURGICAL AND MEDICAL TREATMENT OF CHRONIC CHOLECYSTITIS

By J TATE MASON, M D

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WE HAVE endeavored in this follow-up study to record the late results obtained from surgical treatment and from medical treatment of patients suffering with cholecystitis. In this effort we have selected those patients whose histories were written and on whom a diagnosis of gall-bladder disease was made from five to fifteen years ago. In order to draw some rather definite conclusions from this investigation, we have used a limited group of patients, selected because they were suffering from well-defined chronic cholecystitis without complications. Thus those patients with acute cholecystitis, empyema, jaundice, or carcinoma have not been included. The histories, which were written five or more years ago, have been reviewed, and questionnaires have been sent to the patients, and a number of personal interviews have been held, particularly with patients who have not received relief.

This group of patients have not been particularly benefited by the advance in the knowledge of gall-bladder disease which has been made recently. Few of these people had the aid of cholecystography, which, while not necessarily increasing our accuracy in diagnosis, is certainly a great aid in arriving at more definite conclusions. Because of our added knowledge of the factors influencing the functions of the liver and biliary passages, the immediate hospital mortality of 6 per cent noted in this group would have been reduced, we find, had these patients been operated upon in recent years to less than 3 per cent. We now know that a diseased gall-bladder is almost always accompanied by inflammatory changes in the liver and in the biliary ducts. A damaged liver functions best with a high glycogen reserve, and ingested glucose gives a more satisfactory rise in blood-sugar than that given intravenously (Ravdin). We know that jaundiced patients have a low glycogen reserve and that when they are dehydrated the liver takes up and restores the glycogen content to normal very slowly. Mann has gone further, since these observations were made, in proving that animals with damaged livers are kept alive much longer on a carbohydrate than on a protein diet. Because formerly these facts were not known, many of the patients in this group were deprived of the benefit of careful selection of the time for operation. When the liver is carrying a high glycogen reserve and when diet has been controlled to such an extent that the necessity for detoxification of protein by-products by the liver is at a minimum, the operative risk is least.

Again, any change of mechanism, whether due to hepatic cell damage or to chemical activity, which depletes the liver of its glycogen reserve increases the operative risk.

## TREATMENT RESULTS CHRONIC CHOLECYSTITIS

### REVIEW OF THE SYMPTOMATOLOGY OF 600 PATIENTS WITH CHRONIC CHOLECYSTITIS

Six hundred histories out of a series of approximately 1,500 cases diagnosed as chronic gall-bladder disease were studied in detail. There were approximately twice as many females as males in this series. Twelve hundred of these patients have had the gall-bladder as the predominating cause of trouble and 300 as a secondary lesion. The familiar saying that gall-bladder disease usually occurs in females who are fair, fat, and forty has not been true in this series except in a part of the cases, as review of these histories showed that 35 per cent of the patients were under the age of forty and 43 per cent of the females weighed less than 140 pounds. The average age of the patients when seeking relief was approximately forty-five years.

In comparing the histories of patients suffering from duodenal ulcer and from chronic cholecystitis, it is interesting to note that 50 per cent of our patients with duodenal ulcer stated that the onset of their gastric symptoms occurred before the age of twenty-five, while only 22 per cent of the patients with disease of the gall-bladder began to have symptoms before twenty-five years of age.

The approximate relative frequency of abdominal organic diseases causing dyspepsia, which was reported by Blackford and Dwyer several years ago in a study of 3,000 patients complaining of gastric symptoms, was gall-bladder disease eleven, duodenal ulcer five, gastric cancer two, and gastric ulcer one. During the past ten years our figures relative to this statement have not varied by as much as 2 per cent.

Until very recently we have considered pain as a cardinal symptom of disease of the biliary tract. A few years ago we hesitated before arriving at a diagnosis of gall-bladder disease without this as the chief symptom. In this series, localized pain or soreness of varying degrees was a common complaint, but only 18.5 per cent gave a history simulating that of one or more attacks of gall-stone colic.

Approximately three-fourths of the patients of this series sought relief on account of chronic gastric disturbances, and in over half of these the gastric symptoms had persisted for more than ten years. These disturbances consisted first of food selection, which was the most frequent complaint. The foods most commonly avoided were those that were rich and highly seasoned, fried meats, cooked cabbage, and raw apples. The next most annoying complaint was gas and belching and a feeling of fullness in the epigastrium after meals.

*Gastric Analysis*—The gastric analysis was recorded in 402 cases. In more than half of these patients it was found that free hydrochloric acid was absent from the gastric contents or was definitely below normal. In only 6.7 per cent was free hydrochloric acid above normal. We hesitate in the pres-

ence of a hyperacidity to make a diagnosis of cholecystitis on a patient presenting a history of chronic indigestion

The tabulation of the condition of the gastric acids in this series, with the number of cases and their percentages, was as follows

98 cases in which there was no free acid	24.3 per cent	} 55.7 per cent
126 cases in which the acids were low	31.3 per cent	
151 cases in which the acids were medium	37.5 per cent	
27 cases in which the acids were high	6.7 per cent	

#### THE RESULTS OF SURGICAL AND MEDICAL TREATMENT IN 200 CASES OF CHRONIC GALL-BLADDER DISEASE

There have been 100 surgical patients and 100 medical patients studied. It is hoped that by a comparison of the degree to which each series of patients has obtained relief after a period of at least five years, a more exact comprehension of what each method has to offer in the way of therapeutic results may be arrived at. As stated before, these cases were so selected that they represent a consecutive series of patients suffering from chronic gall-bladder disease. In the surgical group of patients it was not difficult to select this series, but the manner of selection of a comparable medical series presented more of a problem. First the records of all patients who had received a diagnosis of chronic cholecystitis were carefully studied. Those which did not have associated upper abdominal disease were classified into four groups. In Group I were placed the cases that anyone would concede to be proved diagnoses. Either the gall-bladder had been found at operation for other abdominal disease to be unmistakably pathologic, or, as was more frequently the case, a perfect history of classical gall-bladder disease was obtained. In Group II were placed those cases in which cholecystitis was obviously present, but in which actual proof such as visibility of stones or history of painful jaundice was lacking. In Group III we have placed two classes of cases. The one class consists of those patients in whom there was present at times severe abdominal pain, which, however, was either not described in sufficient detail or was atypical or else occurred acutely only once, although it was presumably biliary colic. The second class consists of those patients suffering from dyspepsia of a reflex type, but not accompanied by colic or other objective evidence of biliary disease. Finally in Group IV were placed those cases in which the diagnosis of chronic cholecystitis was made upon a suggestive history without further objective evidence of gall-bladder disease, in which, however, disease of the stomach and duodenum had been ruled out. Group IV manifestly contains the greatest number of errors in diagnosis, and consequently this group has been omitted from the study. The remaining three groups were handled separately, but, as there seemed to be no significant variations in their therapeutic results, they are combined in the diagrams to be shown and in the figures which will be given.

## TREATMENT RESULTS CHRONIC CHOLECYSTITIS

It must be appreciated that of these two series of cases—those treated medically and those treated surgically—undoubtedly the surgical patients were the more ill of the two. The ages were approximately the same. The fact that the late mortality was higher in the surgical group seems further to support the impression that of the two groups of patients those treated surgically were the sicker. We found that of those on whom surgical operation had been performed for gall-bladder disease 10 per cent had died at the time of sending out the questionnaires. Of the medical series 6 per cent had died, 1 per cent of which deaths was due to immediate post-operative mortality following delayed biliary surgery, 1 per cent from extra-

### COMPARISON OF MEDICAL AND SURGICAL RESULTS IN CHRONIC CHOLECYSTITIS

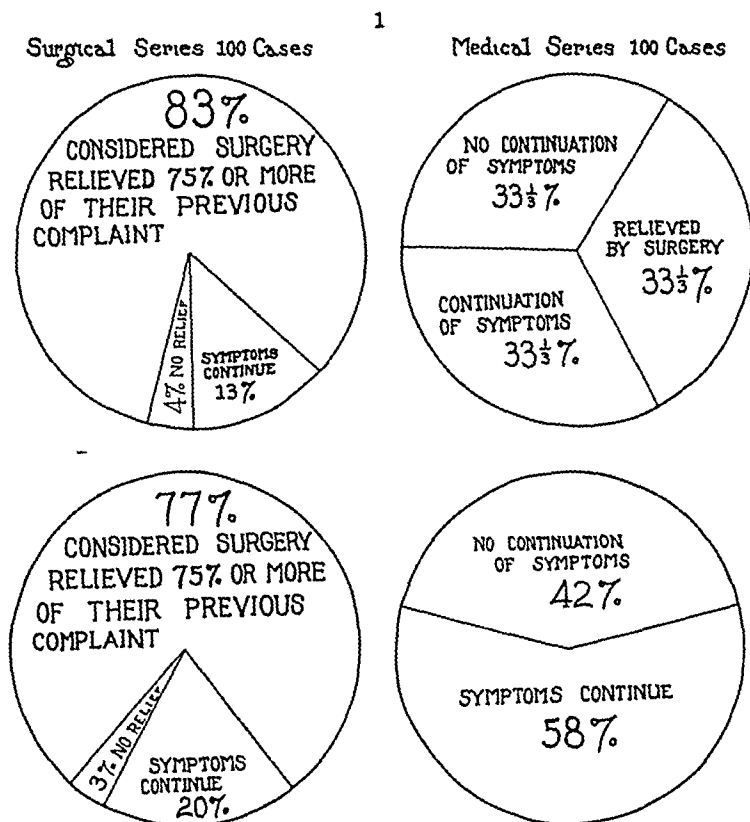


FIG 1

biliary surgery, and 4 per cent from causes not determined, although in all of these cases the age at the time of death was over sixty-five years.

The medical treatment employed in the 100 cases of this series was of the simplest. It consisted almost entirely of dietary control and bowel management. Sodium acid phosphate and bile-salts were usually given, but none of the more elaborate therapeutic devices were used, such as duodenal drainage, *etc*. It is interesting to note that a majority of these patients (four-fifths) had worked out for themselves, without medical advice, a diet which excluded most of the foods which a physician would exclude in instituting dietary control. In this comparison we have tried to show by chart what this group of patients stated concerning the degree of relief of all symptoms, the



condition of digestion, the amount of gas, the presence or absence of colic, and the actual condition in regard to food selection

The medical series studied was interesting for the fact that the patients could be divided into three groups. One-third of the patients, because of continual pain, dyspepsia, gas, and belching and in some cases because of the development of an acute condition, were operated upon. The next third continued to have the symptoms, without relief from dietary control or medicine, and should have been operated upon. The remaining third were completely relieved of symptoms following medical treatment over a period of one to six months.

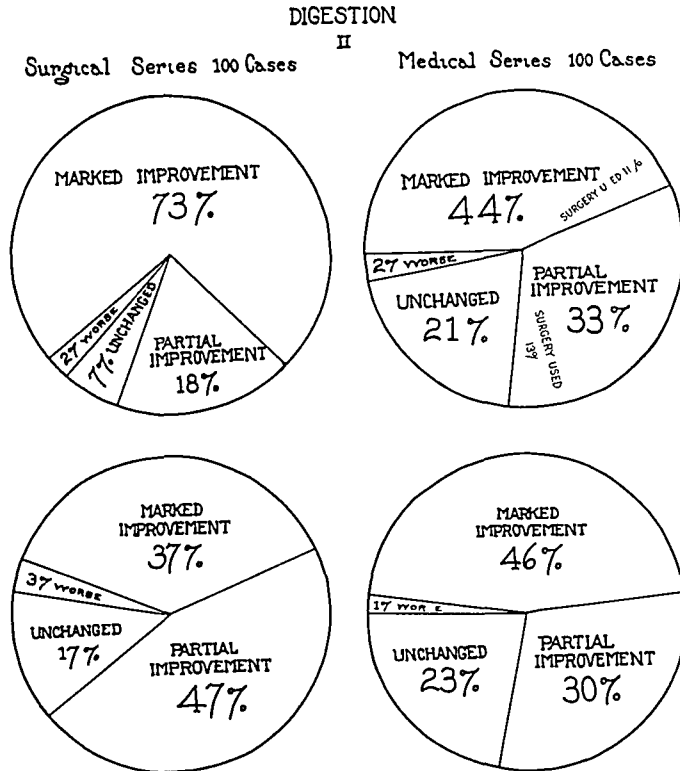


FIG. 2

In the surgical series we find the following results. Regarding the relief of the symptom of pain by cholecystectomy, 83 per cent considered that the operation had relieved 75 per cent or more of their previous complaint, and 56.2 per cent stated that they had been completely relieved of all their old symptoms. Thirteen per cent continued to have symptoms as before, and 4 per cent had no relief. Of the four patients who answered that they had received no benefit at all following their operation, the gall-bladder in two cases was found markedly diseased, in one case the gall-bladder was white, and in the fourth case the patient was a marked neurasthenic. In none of these cases were stones found at operation.

Dyspepsia brings more patients with disease of the gall-bladder to the physician than any other complaint. Consequently the degree of relief of

## TREATMENT RESULTS CHRONIC CHOLECYSTITIS

this condition is a fair index as to the benefit derived from removal of the gall-bladder. In answer to the question regarding this condition, 73 per cent stated that their digestive disturbances were greatly relieved, 18 per cent partially improved, 7 per cent unchanged and 2 per cent worse.

Gas and belching have been stated to be the most common and annoying complaint with most people with disease of the gall-bladder. After operation these symptoms were either absent (37 per cent) or markedly relieved (46 per cent) in 83 per cent, no change was noted in 12 per cent, and 4 per cent stated that they considered themselves worse following the operation.

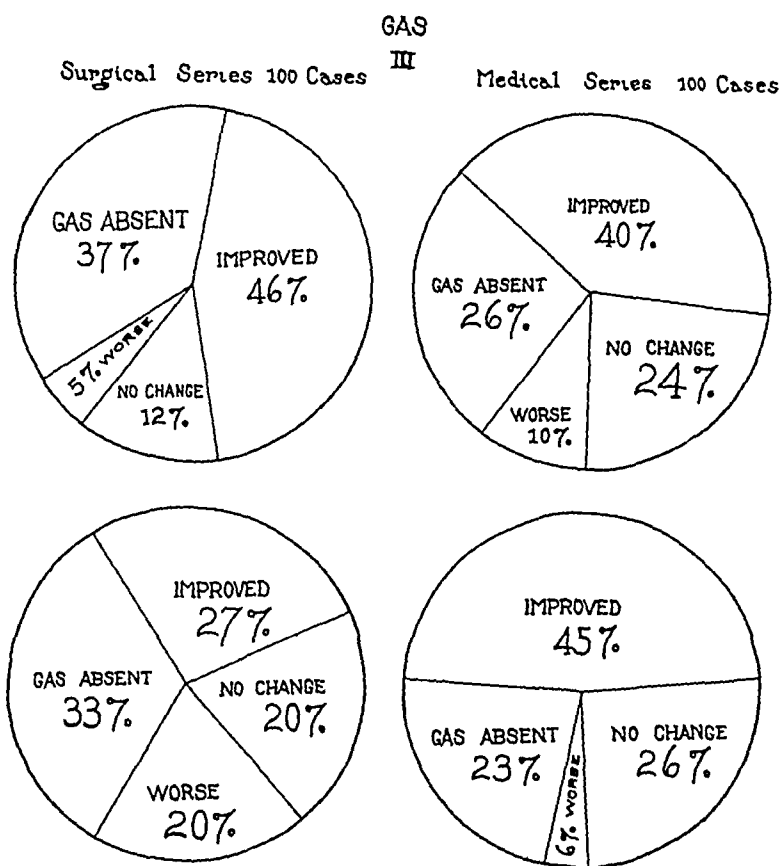


FIG 3

The continued absence of free hydrochloric acid in the gastric content is the cause of the failure of some patients to receive much relief of their digestive disturbances following cholecystectomy.

Food selection is another frequent complaint, as noted above. In answer to the question as to whether or not the removal of the gall-bladder permitted these patients to eat without distress certain foods that they could not eat before, 68 per cent replied in the affirmative. Many patients were very emphatic in their statements relative to this question, affirming that they could now enjoy many foods which would previously have caused them great distress. Thirty-two per cent stated that they noticed no particular difference following the operation, and only 2 per cent felt that

they were worse in regard to food selection than they had been previous to the removal of the gall-bladder

Colic, which is considered a common symptom of patients with disease of the biliary tract, occurred in 18 per cent of the patients before surgical and medical treatment had been instituted. We find that 17 per cent still reported colic after surgical treatment, but that most of these patients had only one or two attacks and these in the first year following their operation. Five years ago we were not draining the common and hepatic ducts nor investigating for stones as often as we are today. This may be the reason for this

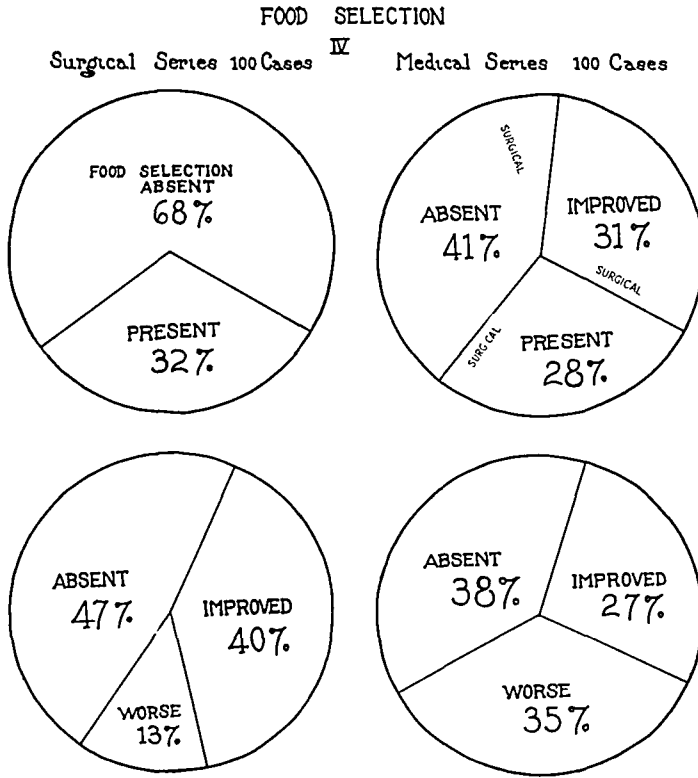


FIG 4

rather high percentage of patients having colic following their operation. The exact cause of gall-bladder and duct colic not due to calculi has not yet been definitely established, as many of these gall-bladders and ducts did not contain stones, only 45 per cent of the total series being found at operation to have stones.

#### CONCLUSIONS

(1) One-third of the patients treated medically came to operation from three to five years after diagnosis was made, one-third, because of the continuance of their symptoms, should have come to operation, and one-third under medical management became symptom free.

(2) Patients who have allowed their gall-bladder symptoms to go on for a number of years until their gastric acids have become low or absent, with

## TREATMENT RESULTS CHRONIC CHOLECYSTITIS

definite and permanent pathology of the liver and biliary ducts, cannot expect as complete relief following cholecystectomy as if they had received immediate operation

(3) Approximately 30 per cent of cases of chronic cholecystitis are relieved of their symptoms under medical management. This indicates that surgical treatment should not be advised in every case of chronic cholecystitis. We believe that a short period of medical management should be advised. If then the patient does not fall into this 30 per cent of markedly improved patients, surgical interference should be instituted at once.

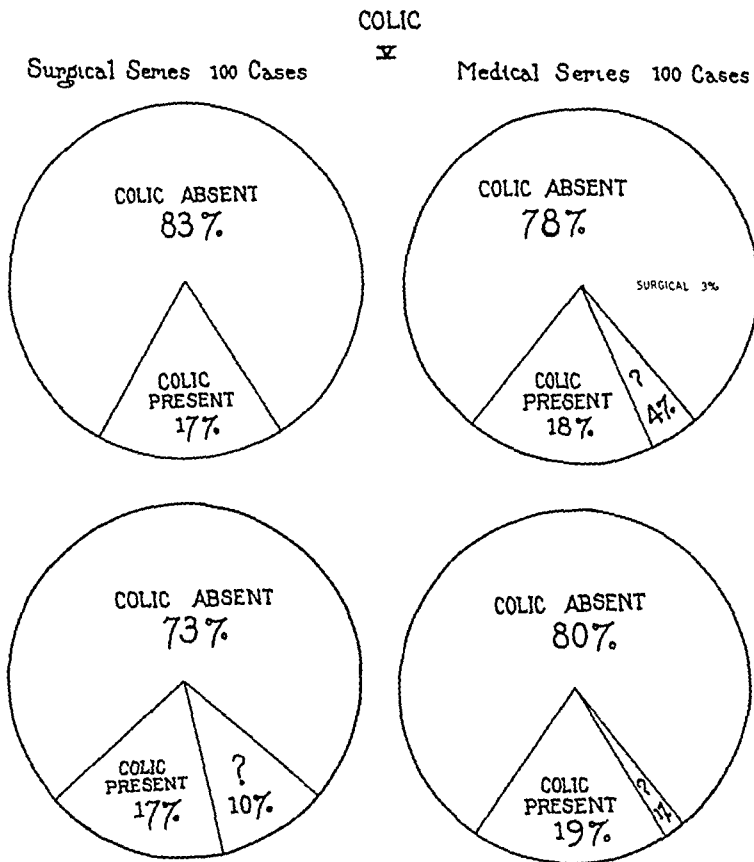


FIG 5

(4) The fact that 83 per cent of those treated surgically stated that they considered the operation a cure for the symptoms for which they sought relief and that many of these cases had very little macroscopic pathology described at the time of the operation indicates that the surgeon should not be hasty in deciding against removal of the gall-bladder because of its normal external appearance when he knows that disease of the gall-bladder was diagnosed only after careful clinical, roentgenologic, and laboratory examination. The lack of the appearance of gross pathologic changes in the gall-bladder *in situ* fails to outweigh careful clinical and laboratory deduction.

(5) Those cases in which food selection is the most marked are less apt to respond to medical treatment.

# TUBERCULOSIS OF THE ŒSOPHAGUS

REPORT OF A CASE WITHOUT ACTIVE TUBERCULOSIS ELSEWHERE

By FRANZ TOREK, M D

OF NEW YORK, N Y

TUBERCULOSIS of the œsophagus occurs rather infrequently, and it is still more rarely recognized. Most of the diagnoses were made at autopsies as accidental findings in patients who died of tuberculosis. In the literature no case is reported in which the lesion of the œsophagus was not accompanied by advanced pulmonary or intestinal tuberculosis. The following case is of interest because the œsophageal lesion was the only active tuberculous focus that could be found in the patient.

H N, a man, sixty-nine years old, stated that he had never been sick until about three months ago, when swallowing became more difficult than usual. Some ten weeks before I saw him he began to regurgitate his food within fifteen minutes after deglutition. Soon after, all solid food came back immediately, even butter and fat would not go down, only milk and soup. He complained of nothing else, but he lost over twenty pounds in two months, most of it in the last two weeks. He was in the Fifth Avenue Hospital from August 14 to September 5, 1930. Rontgenograms taken there August 18 by Doctor Cole showed obstruction at the lower end of the œsophagus. In most of these pictures the end of the œsophagus looked like a blind pouch with a smooth outline, as in cardiospasm (Fig 1). Doubtless cardiospasm had been present when those pictures were taken, but one of them (Fig 2) showed the condition when the spasm let up revealing an irregularity of the outline for about one and one-half inches further down, not unlike the appearance in carcinoma. While at the hospital, his lungs were examined, and a few moist rales at both bases posteriorly were found, otherwise the lungs were clear. The probable diagnosis of cardiospasm was made. The patient was discharged with the advice to have an œsophagoscopy examination. This was made some time later by Doctor Oberrender, of the Lenox Hill Hospital, who saw a tumor resembling a carcinoma of which he removed a specimen for biopsy. The patient was referred to me by Doctor R. Donald Beck, September 30, 1930. By that time his malnutrition was extreme, and I advised him to reenter the Fifth Avenue Hospital and to submit to a gastrostomy, no matter what the pathologic examination might reveal. He was readmitted October 3, and, in the meantime, the report by Doctor Rohdenburg, director of the laboratories of the Lenox Hill Hospital, established the fact that the lesion was tuberculosis, the picture presenting a tubercle composed of a group of giant cells surrounded by endothelial proliferation which in turn was infiltrated with round cells. No evidence of malignancy was found.

On admission the patient was extremely emaciated, had extensive bed sores at the sacrum and both hips, and appeared as though he was doomed to die in a few days. Therefore, regardless of what other treatment might subsequently be decided upon, the indication for feeding him through a gastric fistula was evident.

On October 4, 1930, I performed a Witzel gastrostomy under infiltration with  $\frac{1}{2}$  per cent novocaine. Through a left rectus incision an exploration was first made. A finger introduced into the hiatus of the diaphragm felt an uneven thickening on the right side of the abdominal œsophagus and the lower end of the thoracic œsophagus extending over a distance of about one and one-half inches. The feel of this was that of

## TUBERCULOSIS OF THE ŒSOPHAGUS

tubercles, there being a number of knob-like eminences, not the more homogeneous feel of a carcinoma. The left side of the œsophagus was much less affected. In the abdomen no liver metastasis was found, no retroperitoneal lymph-node enlargement, no stomach involvement.

After the operation, the food intake at first was satisfactory, and the patient's condition plainly showed some improvement, but in the second week the patient began to lose fluid alongside the tube. When the skin sutures were removed on the tenth day, the whole wound opened showing a total absence of any attempt at repair, just as though the operation had been performed on a cadaver. For some time attempts were made to hold the food in the stomach by tampons, also by the introduction of a larger tube, but, as time went on, these expedients proved less and less efficient, and in the fourth week it was evident that he was losing the greater part of his feedings. So, on October 29, I inserted some new stomach sutures in order to insure at least a temporary closure around the tube, but the patient died on the following day, apparently from exhaustion. Unfortunately an autopsy could not be obtained.



FIG. 1.—The contour of the shadow of this sac-like pouch is smooth resembling that of cardio-spasm in an otherwise intact organ.

FIG. 2.—A temporary let-up of the spasm has allowed the column of barium mixture to descend a couple of inches, thereby demonstrating the seat and appearance of the lesion.

The case is of interest because of the absence of any active tuberculosis elsewhere in the body. On his first admission to the hospital the report on the patient's lungs stated that there were a few moist rales at both bases posteriorly and that otherwise the lungs were clear. Those moist rales were afterwards not found. On his second admission the interest in the case had grown very keen, and his lungs were examined by two other physicians independently of each other. Neither of these two found any trouble at the base. The first reported increased vocal fremitus and relative dullness at the right apex as compared with the left, the other reported diminished vocal fremitus on the left side. So, while they agreed that the fremitus was more perceptible on the right side than on the left, they disagreed as to which of the two sides was the normal. These three lung examinations go to show

how little the physical signs varied from the normal. The sputum contained no tubercle bacilli. After the operation the patient coughed somewhat more, but the examination of several specimens of sputum were again negative for tubercle bacilli. A roentgenogram of his lungs (Fig 3) shows a slight haze at the right apex, on which the report was as follows: "Old fibrotic lesion in the right apex. This has the appearance of a healed tuberculous process



FIG 3—A slight haze at the right apex interpreted as possibly the seat of a healed tuberculosis

Lungs otherwise clear." Further than this the expert opinion would not commit itself, and it seems that this opinion should be accepted, although the patient was entirely unaware of ever having been sick.

Heretofore no case of tuberculosis of the œsophagus has been recorded except in patients with advanced tuberculosis elsewhere. In this case there was positively no active tuberculosis in any other part of the body, much less an

## TUBERCULOSIS OF THE ŒSOPHAGUS

advanced tuberculosis, and the case may very well have been one of primary tuberculosis of the œsophagus

Another point of interest is to be found in the patient's age, as thus far tuberculosis of the œsophagus had not been seen in a patient as old as he was. As to the portion of the œsophagus affected, the case belongs to the rarer ones as only about 12 per cent of the cases were found in the lower third of the œsophagus

Œsophageal tuberculosis occurs in two forms. The most common form is that of tuberculous ulcers which are irregular in outline, unlike the clean-cut punched-out ulcers of syphilis, they have a grayish base and irregularly infiltrated edges. They may present cheesy kernels, and there may be a surrounding œdematous zone. The other form is a hypertrophic sclerosis presenting itself in the shape of a tumor. (Fig. 4.)

The infection is assumed to arise through swallowing of tubercle bacilli, but it is generally believed that the uninjured mucous membrane resists infection with tubercle bacilli and that it must be abraded or otherwise injured to enable the bacilli to establish a tuberculous lesion. Evert saw one such occurrence following cauterization with hydrochloric acid, Bieus, Eppinger and Kraus saw one soon after a lye burn. Another mode of invasion is from without inwards, through secondary involvement from tuberculous peribronchial lymph-nodes and perforation of pus and cheesy material into the lumen of the œsophagus. This kind of involvement has a tendency to heal, if the amount of tuberculous overflow is not too great. The resulting scar causes the well-known traction diverticulum.



FIG. 4.—Œsophagoscopy picture of a tuberculous lesion. After Guisez.

The stenosis is due to a thick submucous infiltration of the wall. The muscle fibres subjacent to the lesion are in a condition of fibrous degeneration.

The œsophagoscopy picture is sometimes characteristic of the tuberculous ulceration described above, but at other times resembles that of carcinoma especially if it is the tumor-like form. Klestadt reports such a case. To differentiate the two conditions a biopsy is often necessary.

For diagnostic purposes tuberculin has been used by Curschmann and was followed by strong general and local reactions.

The treatment is both general and local. The general treatment consists in the usual management of tuberculous patients, with invigorating diet and rest. Curschmann has employed the Rosenbach tuberculin with success in one case. For painful deglutition Lotheissen recommends swallowing one teaspoonful of a ½ per cent solution of anæsthesin hydrochlorate. Cocaine,



alypin, stovaine, and oithoform have also been employed. Bromide, valerian and cannabis indica have been used to counteract the accompanying spasm. To the local remedies I would add the swallowing of barium paste, such as is used in X-ray examinations, which has a soothing effect. The local treatment through the œsophagoscope begins with preliminary mechanical cleansing and is followed by one of various kinds of applications, such as argentic nitrate 5 per cent, lactic acid half strength up to full strength, or iodoform. Guisez cured two cases with lactic acid. The use of radium might also be considered. Where a stricture exists, dilatation is permissible only if the ulcerations are not deep. Gastrostomy is indicated in cases of tight stenosis and in those where the analgesic treatment of the ulcers fails to enable the patient to take sufficient nourishment.

## SEVENTIETH BIRTHDAY ANNIVERSARY OF WILLIAM J MAYO

MR PRESIDENT AND FELLOWS OF THE AMERICAN SURGICAL ASSOCIATION

YOUR greetings on this seventieth birthday of mine repay me for living long enough to have it. The day in my thirties when I was elected to the American Surgical Association was the proudest day of my professional life. Each year of membership I have carried to the American Surgical Association that work which I have believed to be the best I could produce. In this connection, I wonder whether it would not be wise for the Association to choose for its Fellows more men in the thirties, with the idea of stimulating them to do their best.

Your Chairman, in his kind remarks, has forgotten the most important factor in what I may have accomplished—that is, my association with my brother. Something more than four years younger, Charlie has stimulated me by precept and example, and our association has been unique not only in the love and confidence we have for each other, but in having made an opportunity for two men to work as one and to share equally such rewards as have come. Even to this day, not only have our fraternal contacts been maintained, but also our habit of having a common pocketbook, in which each has wanted the other to have the greater share. And with due regard to the statement of a truth, my brother, Charles H. Mayo, is not only the best clinical surgeon from the standpoint of the patient that I have ever known, but he has that essential attribute of the true gentleman, consideration for others.

The years have come upon me so easily and so rapidly that I can look back on each and every one of them without regret, and I feel no older now than I did when I came into this Association. As I have watched older men as they have come down the ladder, as down they must come, with younger men passing them, as they must pass to go up, it so often has been an unhappy time for both. The older man is not always able to see the necessity or perhaps the justice of his descent and resents his slipping from the position that he has held, instead of gently and peacefully helping this passing by assisting the younger man. What pleasure and comfort I have had from my hours with younger men! They still have their imagination, their vision, the future is bright before them. Each day as I go through the hospitals surrounded by younger men, they give me of their dreams and I give them of my experience, and I get the better of the exchange. While the older man has his past, with its triumphs, too often the memories of mistakes and failures leave mental scars, which contract and shorten his vision, and as a result sometimes cause him to relinquish the profession.

which is his life and try to develop new fields of interest in which he is not truly interested, and so shorten a life which is no longer stimulating

Before stopping my operative work I visited the clinics of the younger men, and I was convinced that the older man unconsciously loses something of handicraft, something of ready response to operative emergencies. When this became plain to me I was happy to turn, in the interest of the profession that I love so well and of the patients who had been my first thought, from an active surgical career to that of surgical advisor, that I might give to the younger surgeons such of value as I had, and to the patient the benefit of my experience. I have found great satisfaction in what is a change in direction rather than a giving up of my work, in a usefulness which is as delightful as unexpected and which will satisfy me to the end.

As I see the younger men picking up the torch and carrying it on, I realize that scientific truth which I formerly thought of as fixed, as though it could be weighed and measured, is changeable. Add a fact, change the outlook, and you have a new truth. Truth is a constant variable. We seek it, we find it, our viewpoint changes, and the truth changes to meet it.

There are many recompenses in a seventieth birthday. I look through a half-opened door into the future, full of interest, intriguing beyond my power to describe, but with a full understanding that it is for each generation to solve its own problems and that no man has the wisdom to guide or control the next generation. It is a comfortable feeling, to be interested in what is to happen, but in bringing it about to be in no way responsible.

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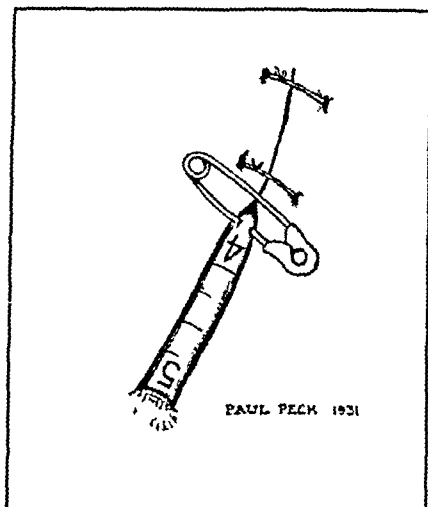


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Fig 2 Illustrates drainage of frontal lobe abscess

Fig 3 Appendectomy with drainage thru McBurney incision



Fig 2

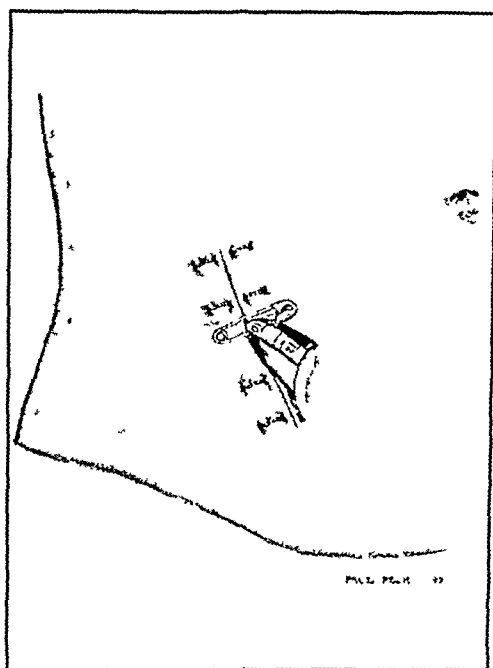


Fig 3

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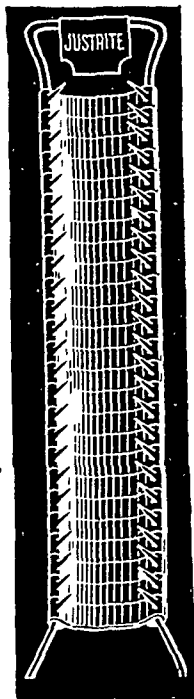
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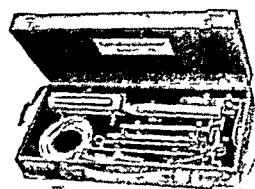
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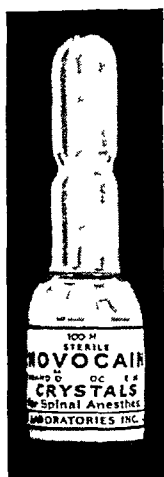
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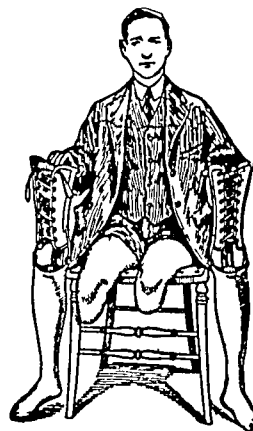
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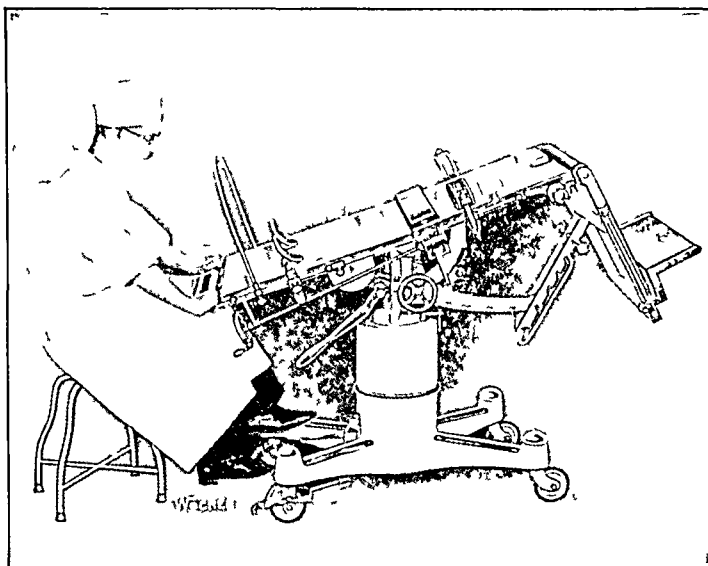
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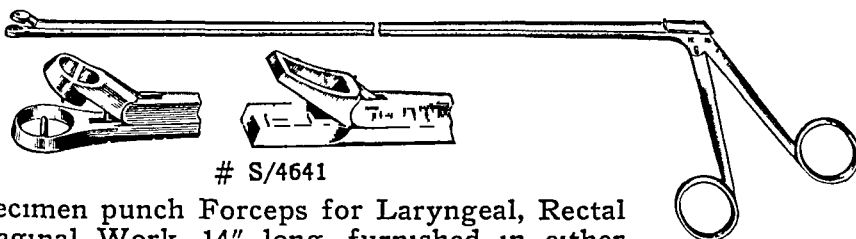
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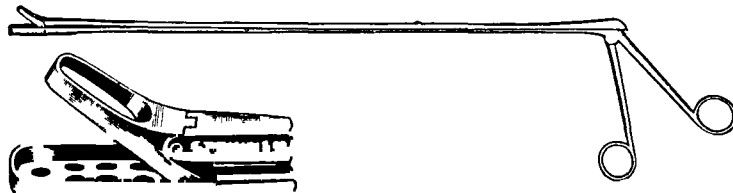
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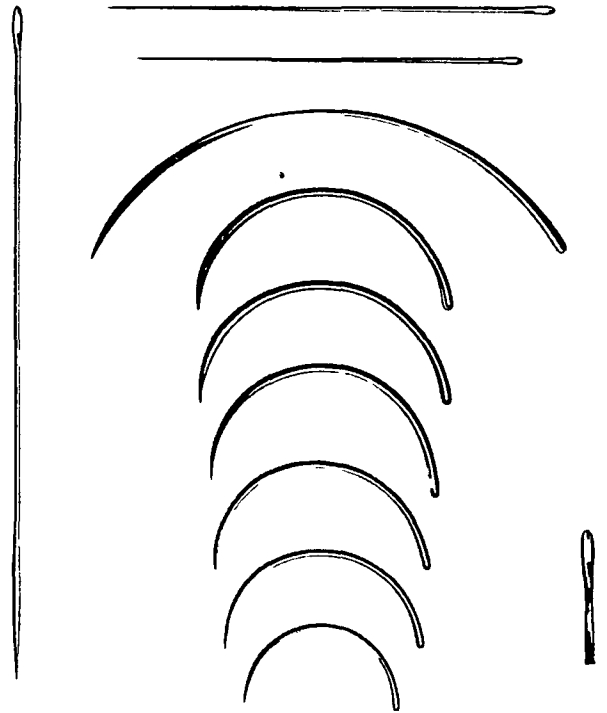
As you know, VIM Suture Needles are made of genuine Firth Stainless Steel, which is noted for its rustless and stainless qualities. Thus the edges and points remain clean and bright. They do not rust. Hence they stay sharp indefinitely.

But the real secret of the fine finish—the uniform and perfect temper of VIM Suture Needles lies in the workmanship. English craftsmen who have spent years in needle making produce these superior needles—made to American specifications. This is the skill which gives you a needle of such strength and ductility.

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That is the reason VIM Stainless Steel Suture Needles have been regarded as so satisfactory—so dependable. To those who know and appreciate these qualities this announcement of a larger assortment will mean much.

For it insures getting almost any size or style Suture Needle that you need, without losing the



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Made in England from Genuine Firth Stainless Steel in the following sizes

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Square Eye Catgut Made in four sizes Nos. 1-2 3 4

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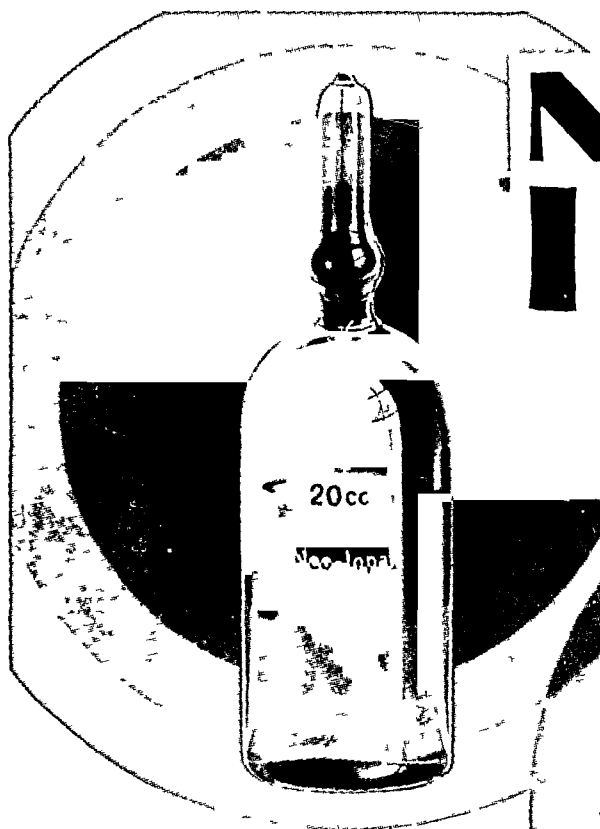
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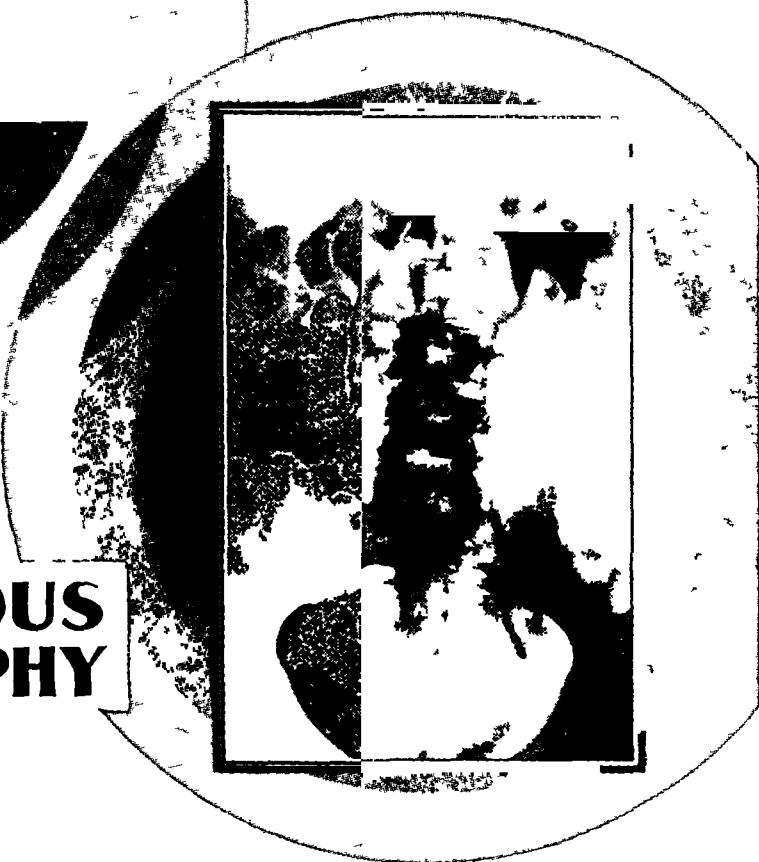
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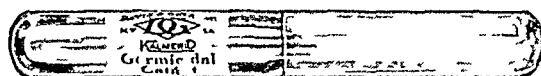
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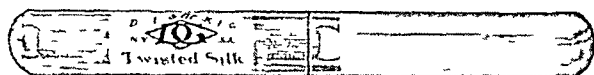


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360	HORSEHAIR	168	00
390	WHITE SILKWORM GUT	84	00, 0, 1
400	BLACK SILKWORM GUT	84	00, 0, 1
450	WHITE TWISTED SILK	60	000 TO 3
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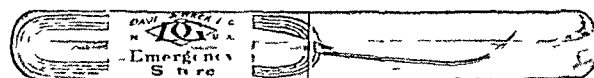
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812	10-DAY KALMERID "	20	00, 0, 1, 2, 3
822	20-DAY KALMERID "	20	00, 0, 1, 2, 3
862	HORSEHAIR	56	00
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984	WHITE TWISTED SILK	20	000, 0, 2

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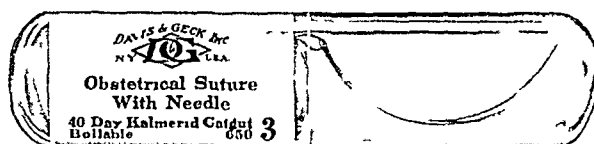
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000	_____	4	_____
00	_____	6	_____
0	_____	8	_____
1	_____	16	_____
2	_____	24	_____
3	_____		

\*These tubes not only may be boiled but even may be autoclaved up to 30 pounds pressure, any number of times, without impairment of the sutures

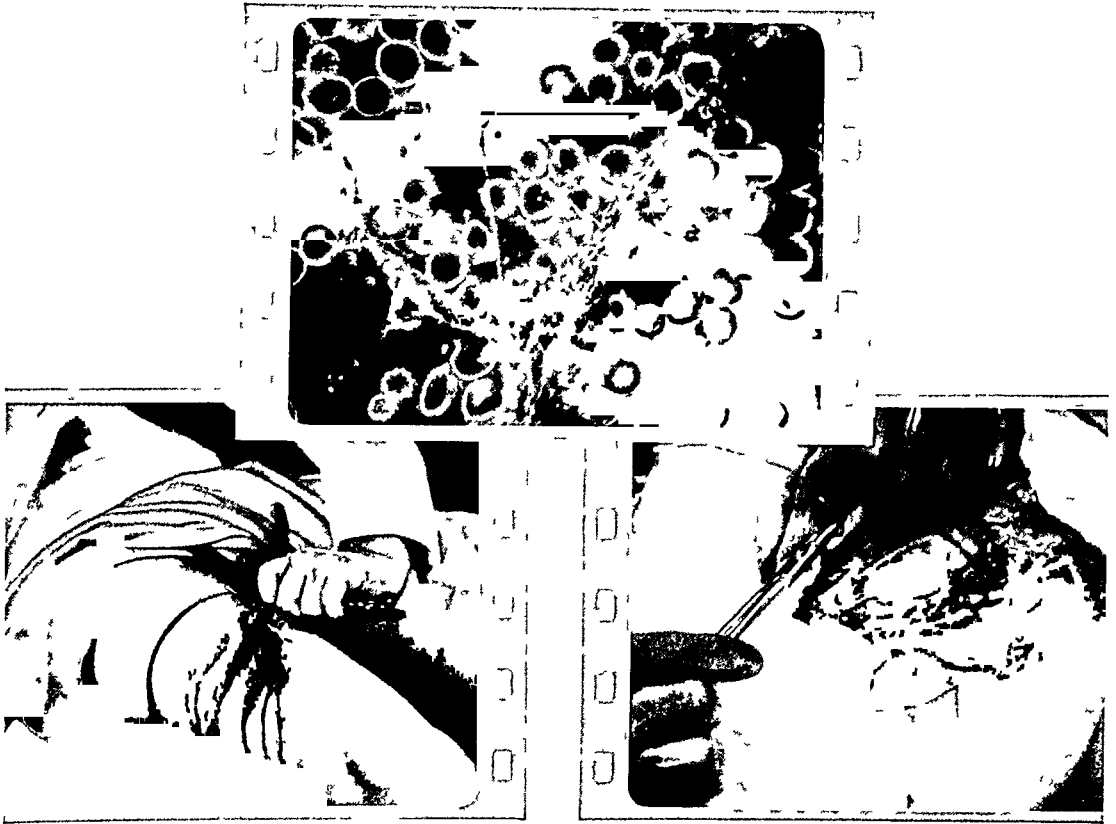
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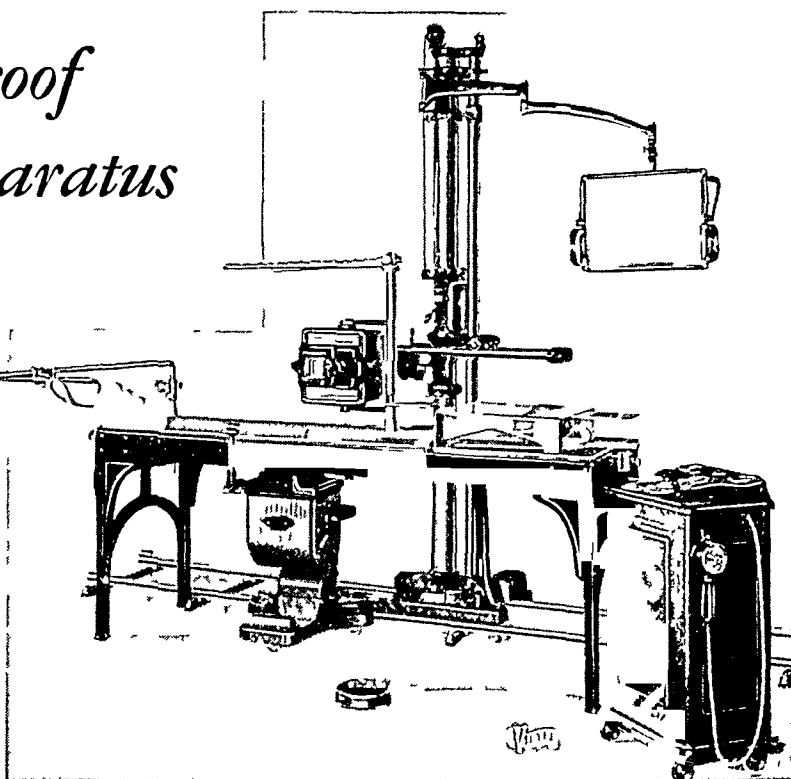
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This illustration shows the Victor Model B 26 Shock Proof X-Ray Unit in position for bi-plane fluoroscopy, with two tube heads, for directing the x-rays from below and crosswise the table, respectively. Note how the McCutchen Fracture Device is adapted to the table. The fluoroscopic screen (at upper right in picture) is swung down into position for observation in either plane, through the two way foot switch on the floor the operator energizes either tube head at will.

having to change the position of the patient. This is accomplished with one shock-proof tube head below the table, another at the side directing the rays crosswise the table. A two-way switch energizes the two tube heads alternately, while the suspended fluoroscopic screen is quickly adjusted to either plane during observation.

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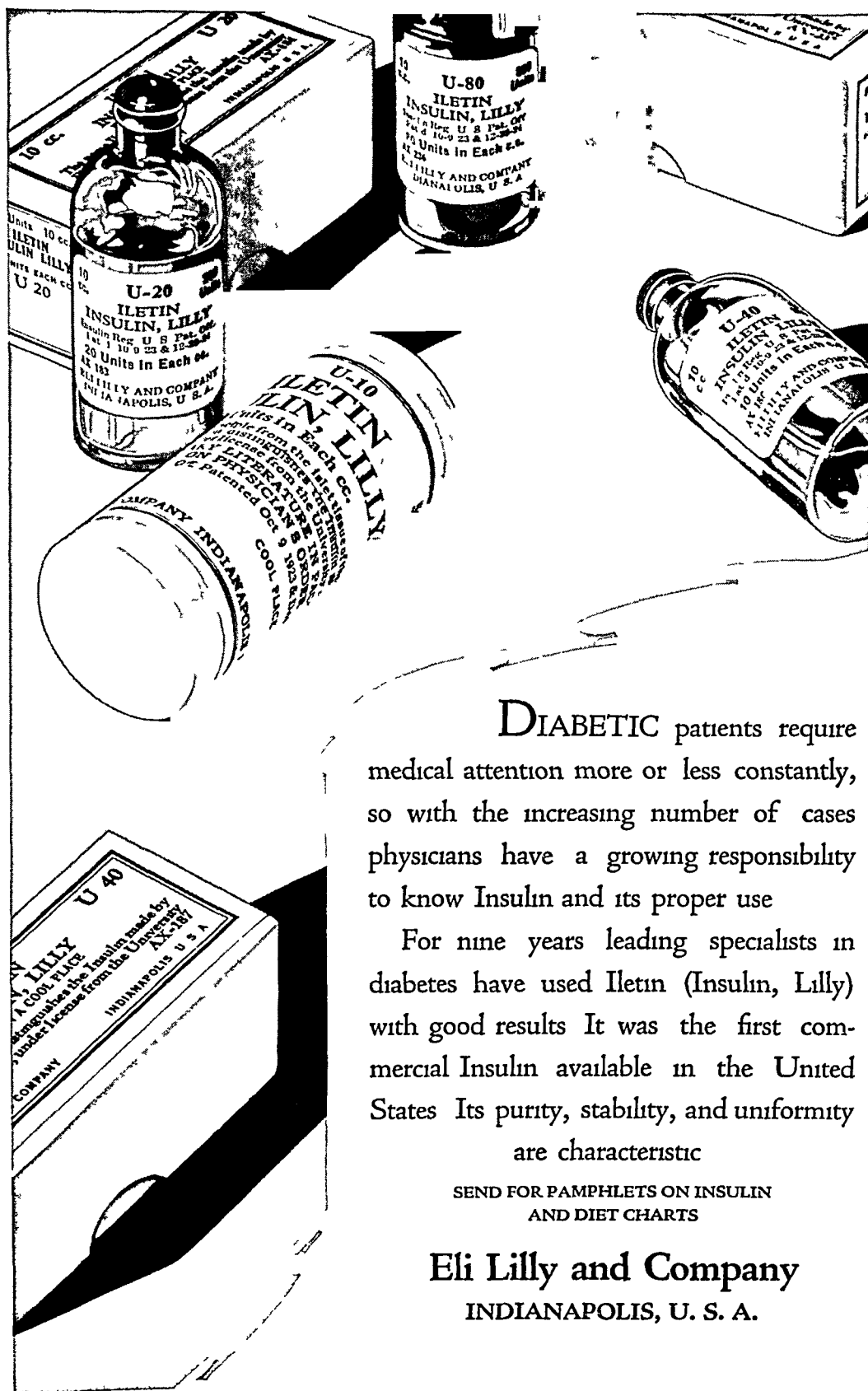
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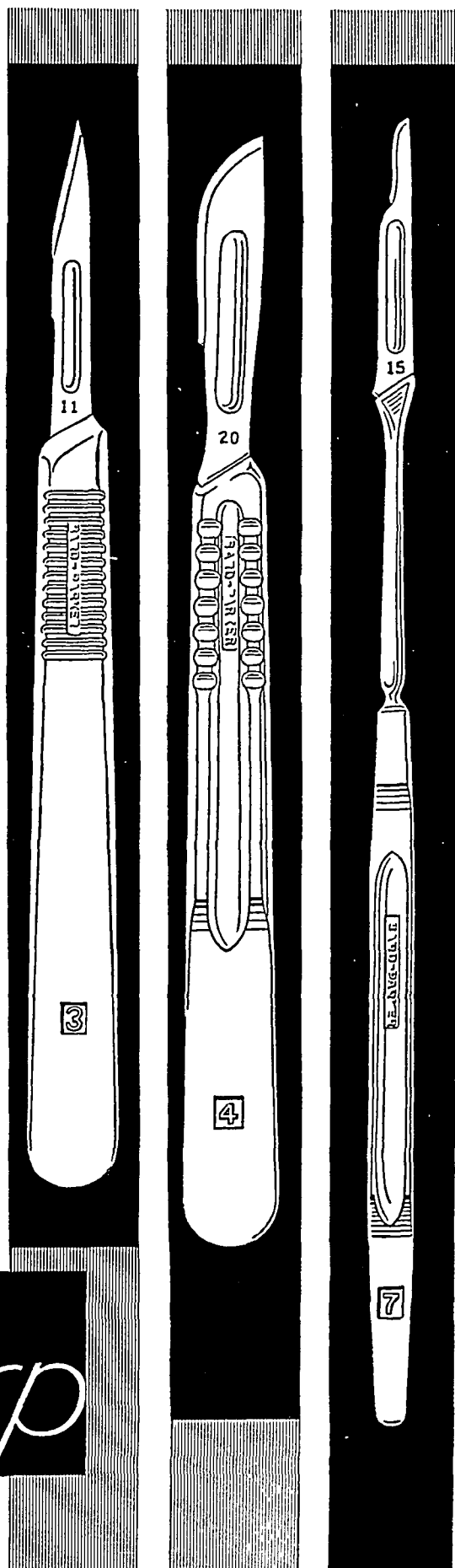
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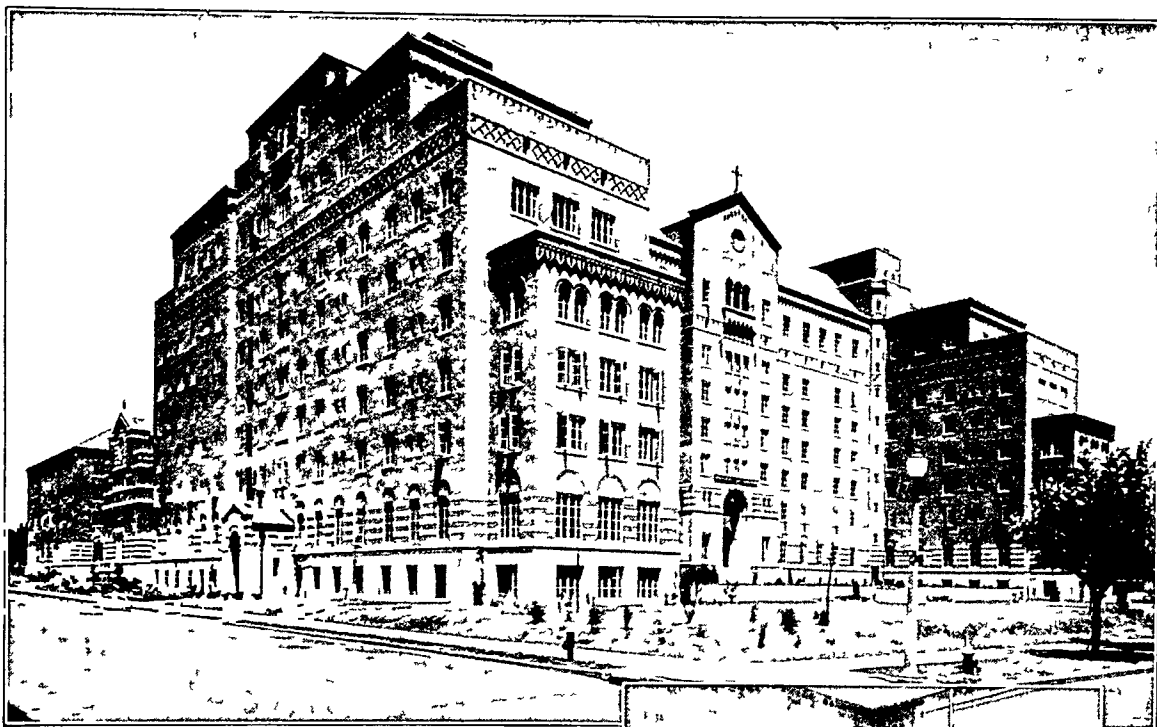
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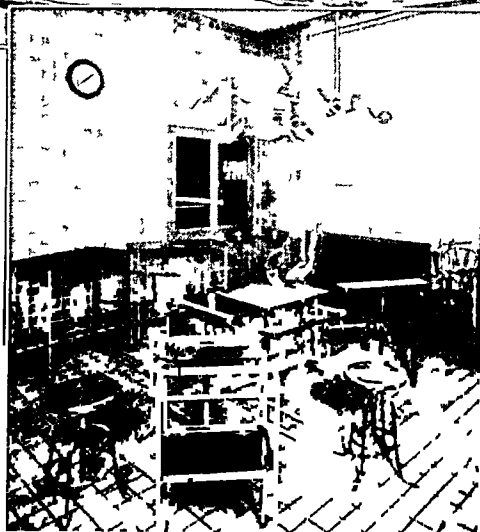
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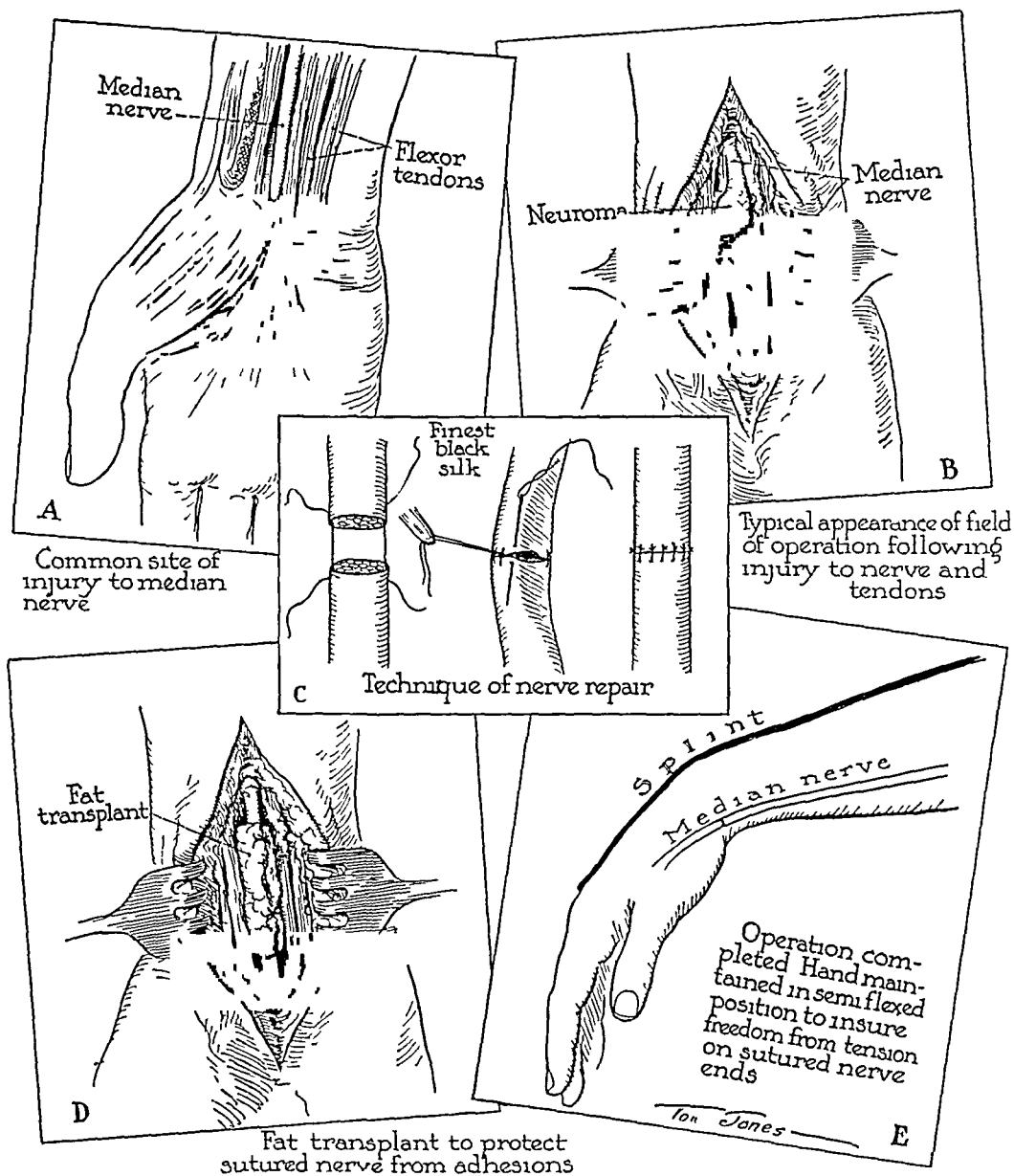
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MEETING HELD JUNE 29, 30, JULY 1, 1931, *Continued*

### IDIOPATHIC DILATATION OF THE ŒSOPHAGUS

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It is the intention to discuss, ultimately from the surgical aspect, a disease of the œsophagus which is neither new, since it was first described in 1821, nor really rare since several hundred cases are on record

When there is in a considerable body of writing, as is shown in the appended bibliography which is continued from Newman's review of the subject in 1900, no agreement even as to the title, a wide divergence of opinion as to the ætiology, and no unanimity as to the treatment, further discussion is not only inevitable, but is even justified

The term "idiopathic dilatation" has been chosen out of many, such as cardiopasm (Mikulicz), phrenospasm (Chevalier Jackson), achalasia cardiae (Hertez), megæœsophagus (Bard), dilatatio ingluvi formi œsophagi (Huss), dilatatio fusiformis (Luschka), and others, because it is one of those most commonly used and does not commit one to a belief in an ætiology, which to say the least is not proven

It may be permissible for those who are interested briefly to review the history of the growing knowledge of the disease, and to indicate the various theories of its occurrence, leaving to a later period a more critical examination of those believed to be more important

The first report of a case seems to be that of Purton, in the London Medical and Physiological Journal, volume xxxvi, 1821

I can do no better than quote here his description of the clinical picture which I have not found improved. An extraordinary case of distention of the œsophagus, forming a sac extending from two inches below the pharynx to the cardiac orifice of the stomach, by T Purton, F L S, F R C S. "The present case, of more than twenty years standing, I believe to differ from any yet recorded. J Broome, aged forty-three, received a severe blow over the breast bone when a youth, which deprived him for some minutes of sense of motion. Ever since, he has labored under more or less difficulty in swallowing. There have been many severe attacks continuing sometimes for three weeks or more and during the whole of this time scarcely any food entered the stomach. Occasionally, however, he was able for months together to propel by violent exertions the contents of the sac into the stomach.

"If the food was not propelled with a certain degree of force, he would reject it, so that latterly he never attempted to use any violent efforts, but would suffer it to remain in the sac for hours or even days.

"No kind of food passed through the contracted cardia until the sac above it was quite distended, nor did he until then attempt to use any voluntary exertion as experience had taught him that previous efforts were ineffectual.

"At dissection, the œsophagus was found forming a sac or pouch reaching from two inches below the pharynx to the cardia. It contained by measurement two full quarts. The cardiac orifice was found pervious but much contracted.

"The poor sufferer had been examined by Sir Astley Paston Cooper, also by most of the medical men of this neighborhood, but he derived no benefit from the treatment recommended." At Sir Astley Cooper's suggestion, it was treated by the passage of bougies. Purton continues "On withdrawing the probang, I was a good deal alarmed by the degree of force by which it was retained fearing lest the cardiac orifice might be lacerated. By gradual, but considerable repulsive force being used, it was at length withdrawn, and, on its passing the orifice, it made a report so loud as to alarm the bystanders."

Subsequent writers have added nothing to the description. None have shown a better dramatic sense.

The next report was by Hanney in 1833, in the Edinburgh Medical and Surgical Journal.



FIG 1.—X ray of infant which shows the opaque meal has entered the first part of stomach. Normal cardiac orifice dilated œsophagus. The meal was immediately rejected by a violent contraction of œsophagus.

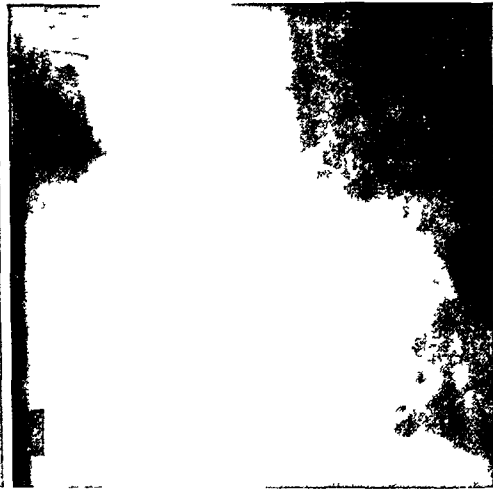


FIG 2.—Showing typical dilatation and narrowed œsophagus at level of diaphragm. Opaque fluid has partially entered œsophagus. Case not operated upon.

There seems to have been some general interest in 1840, for three separate reports are to be found in that year by Rokitauský, Delle Chiago, Fano, and Lindau. M. Curveillier's atlas in 1843 a picture is shown illustrating the disease. By 1877 Zeuker and Ziemssen could collect reports of eighteen cases. Neuman's series of papers in 1900 give the first comprehensive discussion of the subject, symptoms, methods of diagnosis, pathology and treatment. He found, up to that time, seventy cases. They are discussed under the title "Ein fach gleichmassige Erweiterung der speiserohre."

Following this case, reports appear rapidly in the medical journals, so that Theiding in 1921 collected 315.

Beyond this it is unnecessary to go, to show that the disease is frequent enough to be important as well as interesting. It is not far from the truth to say that next to cancer it is the commonest disease of the œsophagus.

By idiopathic dilatation of the œsophagus is meant a considerable dilata-

tion of the organ without an anatomical stenosis, but associated with difficulty in the passage of food into the stomach

It is quite probable, in fact almost certain, that more than one pathological entity has been included in the list, and this has no doubt confused the picture. It would seem slightly probable, for instance, that a new-born infant suffering from violent vomiting in which the fluoroscopic examination shows the food to pass down the œsophagus into the fundus of the stomach only to be rejected by a violent contraction, first of the stomach and then of the œsophagus, and where the œsophagus shows marked peristalsis, is not the same disease as is shown in an adult suffering from an inability to swallow food, where a widely dilated and elongated œsophagus is seen, and there is no peristalsis.

There are also unquestionable instances where in sensitive individuals

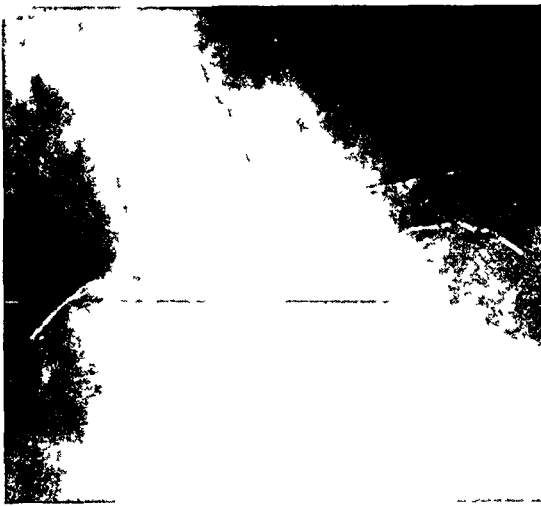


FIG 3—Case J. S.—Pre operative showing dilated œsophagus entrance of opaque meal

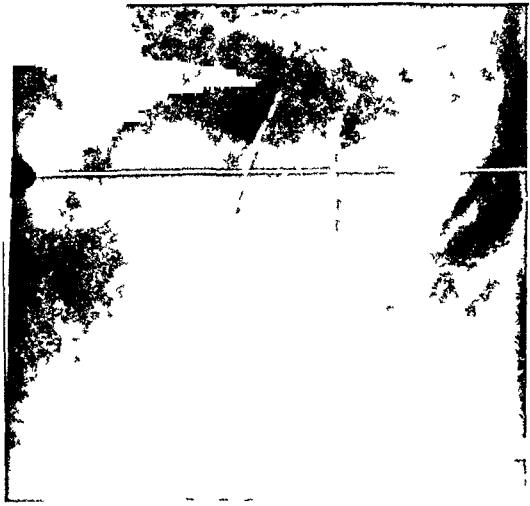


FIG 4—Same case Post operative Œsophagus more upright, fluid opaque meal passing through cardia

emotional disturbances are followed by a temporary or even momentary inability to swallow.

More difficult it is to reconcile those cases which show a very similar appearance under the fluoroscope, yet in the one, the œsophagus fills like a bag, and in the other shows marked or excessive peristalsis. In the author's experience these latter are rare, and though thickening of the muscle is found, peristalsis is seldom seen.

It is almost necessary to review the rather complicated anatomy and physiology of the œsophagus to be in a position to appreciate the effect of alterations.

This description is taken largely from Von Bergman and Staehlm's *Handbuch der Inneren Med.*, 1926, *Abel's Œsophageal Obstruction*, Muller die Lebensnerven and Kuntz' *Anatomy of the Nervous System*.

The œsophagus is a muscular tube extending from the inferior constrictor muscle of the pharynx to the cardia of the stomach. The lower boundary, which is important for this subject, is well marked. On the left side the œsophagus wall makes a sharp

angle at its junction with the stomach. That is termed the cardiac notch. On the mucosal surface the notch is marked by a fold of mucosa and submucosa called the cardiac valve, though of itself it has no valvular action. The right border of the œsophagus is continuous with the lesser curvature of the stomach. The passage from the œsophagus to stomach is further marked by the change from the squamous epithelium of the œsophagus to the columnar of the stomach. The average length of the tube is 25 centimetres, though it varies from 5 to 10 centimetres from this. The diameter, empty, is from 2.3 centimetres at the cricoid cartilage to 2.6 or 3 centimetres at the widest. It is normally about 2.5 centimetres where it passes through the diaphragm.

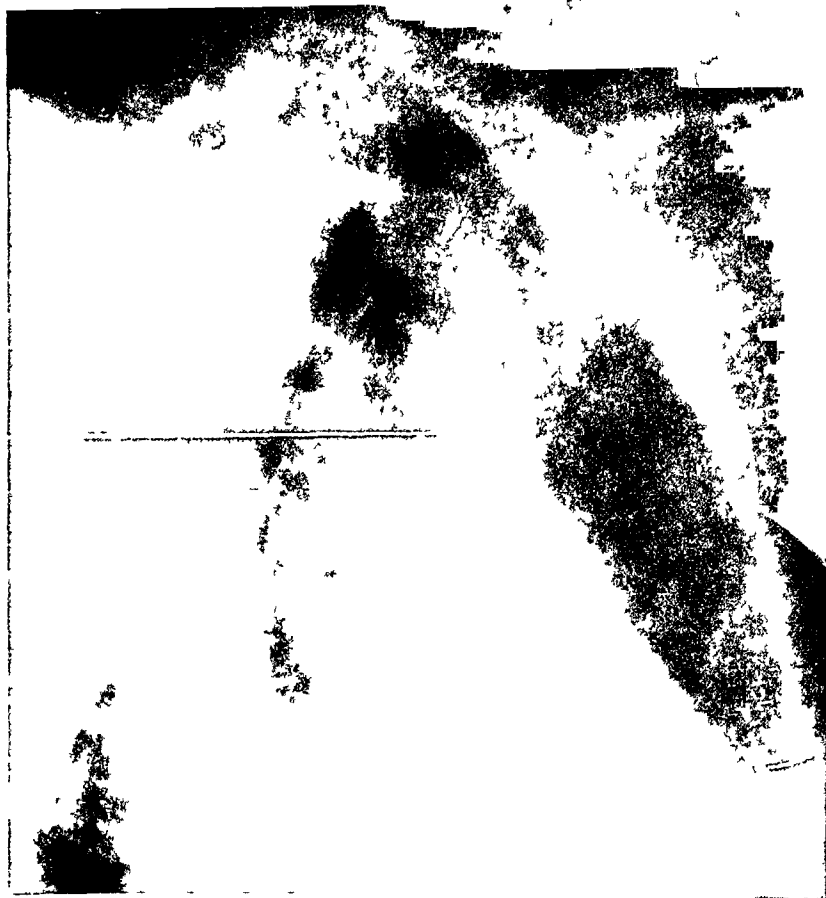


FIG 5—Case I. Four and one half years after operation œsophagus narrow, normal width but still fills to 6 inches before opaque fluid begins to enter stomach.

The upper orifice is formed by the lower fibres of the inferior constrictor muscle and belong more to the pharynx than to the œsophagus. The anterior lip is thin and attached to the cricoid. The posterior lip is formed by a band of striped muscle which, on contraction, closes the opening against the cricoid. The muscular wall of the œsophagus consists of two layers, an outer longitudinal and an inner circular. The longitudinal fibres arise as a tendon, one quarter of an inch wide, from a vertical ridge on the back of the cricoid. This gives rise to two muscular bands which are at first on the front of the organ, then diverge to pass down each lateral aspect, and gradually become a continuous muscular coat.

This arrangement is overlapped by the inferior constrictor of the pharynx, or

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the superior sphincter of the Œsophagus, arising from the thyroid and cricoid cartilages. The lower fibres from the cricoid form a circular bundle transitional between the striped fibres of the inferior constrictor of the pharynx, and the unstriped upper circular fibres of the Œsophagus. These fibres when at rest are in a state of tonic contraction and maintain the upper opening closed.

A most important segment of the Œsophagus from the point of view of the present study is the subdiaphragmatic portion. This is clear when it is realized that the obstruction to the passage of food always takes place at the level of the diaphragm. This section of the Œsophagus is about 3 centimetres long. The left border, as has been stated, forms a sharp angle with the right border of the stomach. At its meeting the right border of the Œsophagus is continuous in line with the lesser curve of the stomach.

The arrangement of fibres of the circular and longitudinal muscle is not entirely clear. There is general agreement that the cardiac sphincter is formed by a thickening of the circular fibres of the Œsophagus to form a definite but not strong sphincter. The arrangement and termination of the longitudinal fibres is not so clear and yet it is essential to know the mechanism by which, during the act of swallowing, the cardia is opened. Forssell has pictured an arrangement of longitudinal fibres which, working together, act as a definite active dilator, and states "The longitudinal muscle surrounding the cardia and the medial longitudinal bundle must, during a general contraction, act as a powerful dilator." Dissections of the longitudinal muscle layer show an arrangement of longitudinal fibres which bend sharply round the angle between the left border of the Œsophagus and continue on into the outer layer of muscle on the right border of the stomach. Thus, together with a fixation of the right border of the Œsophagus in the hiatus, shows at once that a general contraction of the longitudinal muscle somewhat as Forssell suggests must act as a dilator, while a paralysis or inhibition of the fibres will permit the circular fibres by the unopposed exertion of normal tone to close the cardia.

The contention (Chevalier Jackson) that the closure of the Œsophagus is brought about by contraction of muscle bundles from the diaphragm has some anatomical support, but is none the less widely accepted on account, partly, of the difficulty in postulating a synchronized reflex for opening the cardia during swallowing, and from the fact that the hiatus is much larger than the Œsophagus.

The nerve supply (taken largely by Kuntz anatomy of the nervous system) can only be briefly noted.

The Œsophagus is supplied by both vagus and sympathetic nerves. The cervical parasympathetic supply is from the recurrent laryngeal. The two sides do not as a rule join branches. In the thorax, the left vagus passes down supplying the anterior surface, the right the posterior, but both cross over giving branches to both sides. Several branches from the left usually join branches from the right.

The sympathetic supply arises mainly from the inferior cervical. The lower portion also received branches from the thoracic portion of the sympathetic trunks. Some of these fibres go direct, others through the aortic plexus and through the great splanchnic nerve. The vagus and sympathetic form a plexus about the Œsophagus.

The intrinsic nerve supply of the Œsophagus consists, as in the rest of the intestinal tract, of the myenteric plexus situated between the longitudinal and circular muscle and the submucous plexus in the submucosa. These are generally known as Auerbach's and Meissner's plexuses. These two plexuses are connected by numerous strands of nerve fibres and include both fibres belonging to the enteric nervous system and the termination of the parasympathetic from the vagus. The sympathetic fibres which enter the Œsophagus do not end around the nerve ganglia of Auerbach's plexus, but terminate directly in the tissue which they enervate. There is no clear anatomical evidence that the muscles are supplied by sympathetic fibres. The difficulty is to distinguish sympathetic fibres going to blood vessels from those that possibly supply the muscles of the Œsophagus.



From the standpoint of this paper the only physiological interest is the act of swallowing

The description is drawn largely from *Handbuch der Normalen und Pathologischen Physiologie*

There have been three main theories relative to the passage of food through the œsophagus First that it passed by peristaltic action, second that it is squirted by the action of the pharyngeal muscles through a rigidly held tube, and third that it passes

through, in men, by gravity and by its weight overcomes the cardiac sphincter

This latter theory is of particular interest as it affects the understanding of the mechanics of idiopathic dilatation

It can readily be shown that all three play a part It is easily understood that there is a squirt action of the pharyngeal muscle constrictors, but that both the peristaltic action and the weight of the food play a part, is made clear, when the rates of passage as between fluid, semifluid and solid, are compared in the upright and the head-down position In the upright position, fluid passes almost continuously into the stomach through a rigidly held œsophagus and an open cardia, semifluid almost the same but more slowly, while solid food takes an appreciable time and can be seen to pass as a Bolus as by a peristaltic wave In the reversed position a single swallow stays in the upper end of the œsophagus and successive swallows gradually fill the tube toward the cardia, while solid food is still propelled as by a peristaltic wave into the stomach The observation that fluid, in men in the upright position, flows by gravity through the œsophagus into the stomach presupposes the fact that the cardia is held open and offers no opposition to its passage

The act of swallowing though initiated as a voluntary act becomes, during its execution, the swallowing reflex As has been mentioned, the œsophagus is supplied by both vagus and sym-

FIG 6—X ray of dog's œsophagus ten days after cutting of both vagi No food entered stomach. Œsophagus widely dilated and filled with water and food

pathetic nerves, but what part the sympathetic plays is not definitely known and the usual antagonism of the para and sympathetic has not been demonstrated The matter is further complicated because the vagus holds both inhibitory and motor fibres nor can a peristaltic wave be initiated by stimulation of the œsophagus at any one point as it can in other parts of the intestine Stimulation of the central end of a divided vagus while the other is intact results not in peristaltic waves but a contraction of the whole muscles The peristaltic waves are none the less controlled by the extrinsic nerves, and the orderly sequence of the movements of the swallowing reflex are regulated through a medullary centre

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Further, respiration is necessarily inhibited during swallowing. It has not been demonstrated that the intrinsic neurons play any part in the swallowing reflex.

Understanding of the cardiac control is confronted with the same difficulty in that the vagus and sympathetic nerves contain both motor and inhibitory fibres and the response to stimulation varies (Carlson) with the strength of stimulation and the state of tonus in the muscles, if at the moment of stimulation the muscle is relaxed, vagus stimulation results in opening. It has been seen that there is reason to believe that this is an active opening of the cardiac orifice not merely a relaxation or inhibition of a closed sphincter.

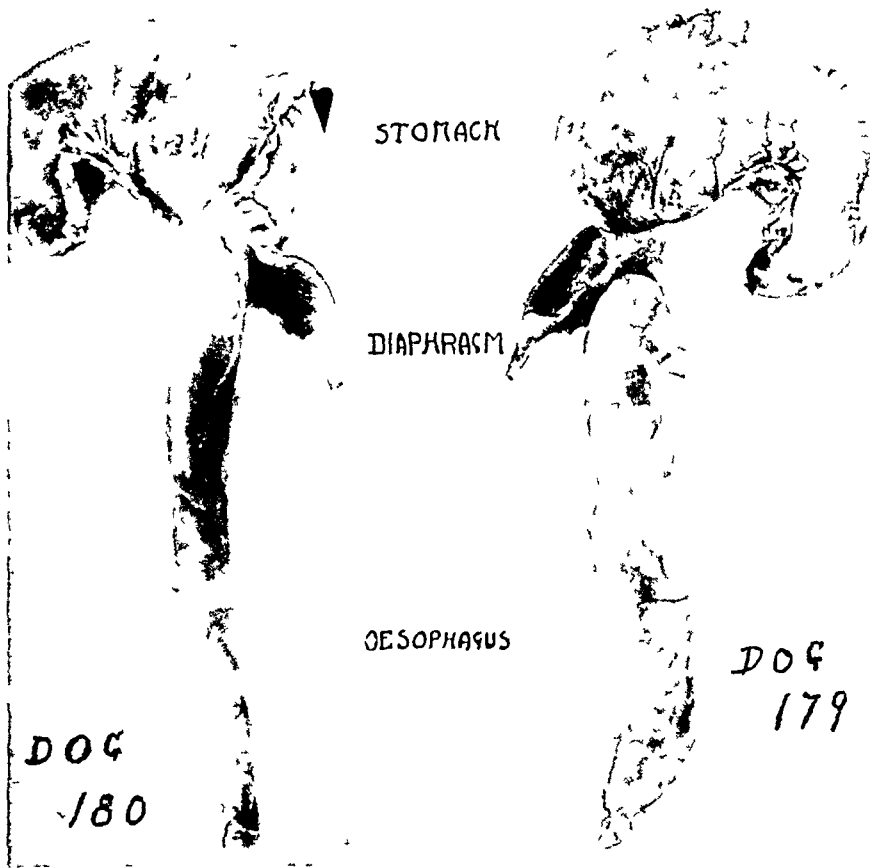


FIG. 7.—Photographs of two dogs' œsophagi after cutting both vagi. Shows paralytic dilatation. Normal cardia. No food entered stomach till death.

*Pathological state*—As to the gross appearance of the œsophagus there is general agreement with no greater variation than would be expected between specimens. There is found in varying degrees both dilatation and elongation of the œsophagus. The dilatation begins at the upper end and gradually increases in the lower third. It may reach its maximum width in its middle portion and gradually taper to the hiatus of the diaphragm, or it may be pear-shape with its maximum diameter immediately above the diaphragm or it may be S-shape with the dilated œsophagus lying over the upper surface of the right diaphragm. These variations are differences of degree and are the expression of the degree of elongation as well as dilatation.

At the diaphragmatic end the œsophagus is almost invariably normal in diameter and the subdiaphragmatic portion is variously described as normal,

small, or pencil-like. It is this subdiaphragmatic portion which is of the greatest interest.

Out of 104 cases seen at operation or post-mortem (Bull) fifty-two were described as normal, and fifty-two as altered. Of the fifty-two altered, in the great majority the description suggests what has been found in each case examined by the author, namely, the dilated œsophagus extends to the diaphragm, but the subdiaphragmatic portion is small and pencil-like, in

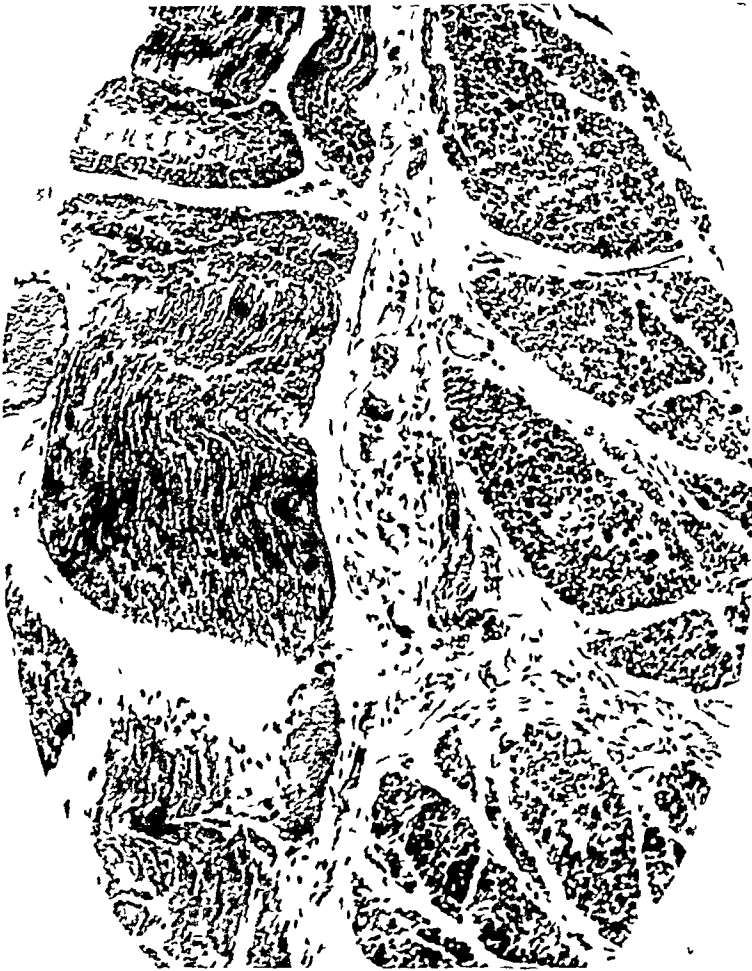


FIG 8—Microphotograph showing normal Auerbach plexus and contains four ganglia cells (Rake)

that sense contracted and the lumen narrowed, but with no hypertrophy or thickening of the muscular coat. In the dilated portion the muscular wall may be found as in Irwin Moores' careful description of three cases either of normal thickness, thinner than normal or abnormally thick from hypertrophy of the muscular coat and inflammatory thickening of the mucous membrane. The lining mucosa may be smooth, but is often ulcerated and the submucosa thickened and infiltrated.

The hypertrophy of the muscular wall is mostly in the circular fibres. A thickened wall is rare but known as two of Moores' cases (Illustrations taken from Moores' paper.)

In all of the five cases observed either at post-mortem or in the operating room, the subdiaphragmatic portion of the œsophagus was distinctly smaller than the normal 2.5 centimetres. The organ appeared as a small round cord in one case about 1 centimetre in diameter, in one nearly 2 centimetres. The muscular wall of this portion was in none thickened, and in two distinctly thin, thinner than the corresponding muscular coat of the stomach. This was in marked contrast to the dilated œsophageal wall immediately above the diaphragm. In each of this small number of cases, the œsophagus immediately above the diaphragm was greatly dilated and lay over on the upper surface of the right diaphragm. The contraction from a diameter of 5 to 6 centimetres immediately above to the small subdiaphragmatic portion (in one case, 1 centimetre) was abrupt and took place at the level of the diaphragm. The hiatus was in each case quite wide and could not actually obstruct the œsophagus, though the appearance of a kink at this level was insistent, both from the enormous difference in diameter of the two portions and the abrupt change in direction in the lumen of the œsophagus.

There was in all a complete absence of hypertrophy of the muscular coat. In one the mucosa was ulcerated so that the tearing through of the muscular coat during the Heller operation resulted in an opening into the œsophagus. The tissue was so friable as not to hold a suture.

Examination under the fluoroscope in each case gave the same appearance. The fluid drink entered the œsophagus by the action of the pharyngeal muscles, fell straight down to the level of the diaphragm and then filled, from the bottom, to show a fluid level of varying height according to the quantity taken. There was no vestige of peristalsis. At the time of examination in this group, no fluid entered the stomach, in some others where the opportunity to confirm the observation was not given by operation, that is, in the lesser degrees, some fluid began to enter after a head pressure of from 10 to 12 centimetres was reached. Then fluid began to trickle in a fine stream into the stomach. In these which were of lesser severity, the dilatation of the œsophagus was not so great, nor did the œsophagus lie over on the right half of the diaphragm.

The fluid head could therefore exert its force on the closed cardia, while in the more widely dilated and elongated cases it seemed the greater the weight of fluid the more firmly was the cardia closed.

In some instances the capacity of the œsophagus is enormous up to 1, 2 or even 3 litres, with a circumference up to 30 centimetres. It is noteworthy, as has been repeatedly recorded, that the dilatation in this disease reaches a far greater degree than is ever seen in mechanical obstruction by neoplasm or scar. One objection to the theory of a primary atony has always been the presence of an hypertrophied muscle in the dilated portion of the stomach and this has been held by Starck to exclude the possibility on the ground

that a paretic muscle does not hypertrophy, but as Chizzola points out that does not dispose of the case

First there are the pseudo-hypertrophies associated with loss of power. There is the thickening of the wall apart from the muscular thickening, there is the analogy of the megacolon with hypertrophy and contraction but no advance of the contents and there is, above all, the fact that in the great majority of cases seen, no peristalsis can be seen under the fluoroscope so that while there may be contraction it may well have lost its coordinated sequence

There has been great difficulty also in interpreting the experimental evidence of the cardiac innervation. Many seemingly contradictory reports on the evidence of vagus and sympathetic stimulation are found, but the main trend of evidence points to the conclusion that there is both vagal and sym-



FIG 9—Microphotograph showing diseased plexus. Nerve fibres replacement fibrosis but no ganglion cells (Rake)



FIG 10—Microphotograph from Case II showing changes described by Rake

pathetic influence and that in general the action is comparable to that found elsewhere in the intestine and this in spite of the fact that peristalsis cannot be initiated by stimulation of one part of the œsophagus

There is anatomical ground for believing that atony of the longitudinal muscle must result in an inability to open the cardia and that there a break in the parasympathetic paths would result in a loss of tone in the œsophagus permitting dilatation and an inability to open the cardia in rhythm with the swallowing reflex

Ever recurring in the writings is the difference of opinion as between a primary spasm of the cardia and secondary dilatation of the œsophagus as believed by Miculicz, and an achalasia or failure to open as originally suggested by Meltzer. Against the principle of primary spasm of the circular muscle of the subdiaphragmatic portion of the œsophagus, it is always argued first that an obvious stenosis never results in a dilatation of anything like the degree usually found in idiopathic dilatation, second, that there is

never found any serious opposition to the passage of sounds, not more than would be found in the tonic closure of the unopposed circular fibres

This is supported by the behavior of ingested fluid under the fluoroscope, third, that there is rarely found any hypertrophy of the circular muscle fibres which form the sphincter

Anatomically, as shown by Forssell, and easily to be confirmed by dissection, there is an adequate muscular arrangement of the longitudinal fibres to open the cardiac orifice in rhythm with the swallowing reflex. It has been noted, and the evidence given for the belief, that fluids flow through the œsophagus into the stomach largely by gravity in the presence of an actively opened cardia and that this opening is accomplished by means of the contraction of the longitudinal muscles. If this be true then Kraus's theory gathers weight that the dilatation of the œsophagus and the closure of the cardia are brought about by some failure in the vagus path, by which the œsophagus becomes atonic, dilated and elongated, that this is necessarily accompanied by a loss of ability to actively open the cardia which remains closed by the tonic contraction of the circular sphincter fibres. This seems to the writer to be in accordance with the observed cases. Bougies pass with little or no opposition into the stomach

Under the fluoroscope in the less severe degrees of the disease, fluid can be seen to fill the œsophagus to form a head, and then pass into the stomach as if the weight of fluid had forced the weak sphincter. In the more severe degrees this does not take place and in these there is noted a marked elongation of the œsophagus which lies like a sac over the right half of the diaphragm. In such instances the head of fluid cannot act to a mechanical advantage, but on the contrary the greater the filling the more marked the kinking of the œsophagus at the diaphragmatic level. Kraus's theory is supported by certain pathologic and experimental evidence

His own case, where the vagi were found degenerated, has remained the only instance where a marked degenerative change has been demonstrated

Cutting of the vagi as Langley and many others proved has confirmed results in an immediate loss of power to swallow fluid or solid food. This is accompanied by a rapid dilatation of the œsophagus and a closure of the cardia which remains permanent till death. Tamiya and other workers with him state that the cutting of one vagus results in a temporary loss of ability to swallow. Owing to the great difficulty in keeping animals alive after section of both vagi, Tamiya injected small quantities of arsenic into the vagi in the neck and stated that they produced more or less stoppage of the food according as the nerves were more or less degenerated. The writer has not been able to confirm this, all the animals either swallowed in a fairly normal way or failed to swallow at all

There is no doubt that section of the vagi will produce a state superficially like that of idiopathic dilatation, yet it cannot be accepted as an explanation,

diaphragm, the bringing down and therefore the straightening out of the elongated œsophagus without touching the muscle as in the Heller operation, or opening the lumen as when an anastomosis is done. The procedure is easily done and should be safe.

The idea of enlarging the opening in the diaphragm has been proposed before, first so far as I know, by Anthony Bassler in 1914 under the influence of Chevalier Jackson's contention that the closure of the cardia is brought about by muscular bands derived from the diaphragm. The procedure carried out in the three cases reported is as follows.

An incision as described by Marwedel in 1910, was made in the left paramedial line beginning about 2 inches above the xiphoid. The muscles are cleared from the cartilages of the seventh, eighth, and ninth ribs and pushed laterally. The cartilage of the seventh rib is cut through at the junction with the sternum, care being taken not to enter the pleura or pericardium. The cartilages of the seventh, eighth, and ninth ribs are cut through at the costochondral junction. In this way a flap consisting of rib cartilages and diaphragm can be retracted laterally exposing the left lobe of the liver. The coronary ligament of the liver is then cut as far as may be necessary to turn the left lobe of the liver down and to the right. This brings one to the fundus of the stomach and the subdiaphragmatic portion of the œsophagus. Loose areolar tissue is cleared away, a large vein crossing the crura ligated and cut. The opening through the diaphragm enlarged by cutting the crura. The fingers are then inserted through this opening and the œsophagus, which lies well over towards the right, freed from surrounding areolar tissue and brought down through the opening for 2 inches or more. In order to do this the right vagus nerve may have to be cut, but since the vagi form a plexus about the lower œsophagus this may be done without danger.

The edges of the enlarged hiatus are then sutured to the thickened muscular wall of the dilated portion of the œsophagus and the wound closed. This procedure has been followed in three cases as the appended case reports will show.

Subsequent examination under the fluoroscope shows that fluid enters the œsophagus as before, fills to a varying point 4 to 6 inches above the diaphragm and then begins to trickle through the narrowed cardia into the stomach.

It is necessary only that food should be finely divided and well mixed with fluid. After a meal it is advisable to take a quantity of water to prevent remnants of food remaining in the lower œsophagus.

#### CASE REPORTS

CASE I—Miss J. P., aged forty-five. Complains of difficulty in swallowing. Onset sudden nine months previous to admission, with vomiting all food. Sensation of food sticking under the sternum with choking sensation. This has continued ever since. Relieved by regurgitation of food. Has gradually got worse. Feels hungry all the time and has lost weight.

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Her weight nine months ago was 170 pounds, now 121 A loss of 49 pounds Feels weak from loss of food

Personal and family history have no bearing on her present illness except that previous to the onset of her present symptoms there had been no gastro-intestinal disturbances

*Examination*—No ability to swallow, regurgitates almost all food, some fluids pass General examination shows nothing abnormal Œsophagoscopy reveals a somewhat æsthetic pharynx, great dilatation of the lower œsophagus, some greenish fluid content Œsophageal wall smooth No ulceration, no bleeding

*Fluoroscopic examination* (films destroyed) shows a greatly distended œsophagus The dilated portion lying over on the right diaphragm No visible peristalsis, six-hour retention of barium drink, none has entered the stomach The examination was repeated under atropine and a similar picture obtained The height of the column of barium retained was about 6 inches Following the atropine she thought she retained food better, but no such improvement could be demonstrated Began night and morning feeding by tube, mid-day meal of fluid attempted without tube No improvement Benzyl benzoate, adrenalin, ephedrin all tried without effect Protein sensitization tests are all negative Regurgitated the noon meal, tube feeding retained Ergotamine tried without benefit February, 1926, transferred to surgery

*Operation* February 28, 1926 Heller extramucosal cardioplasty Marwedal's incision The subdiaphragmatic portion of the œsophagus was found to be three-quarter inch in diameter The wall was not hypertrophied The wall over the cardiac end of the stomach incised down to the submucosa and this incision was extended upward over the lower end of the œsophagus It seemed satisfactory up to this point, when without obvious reason a small leak was observed in the œsophagus This quickly enlarged to a hole about one-quarter inch in diameter as if the mucosa was either ulcerated or very soft The opening was sutured and reenforced by a layer of peritoneal tissue Over this was sutured a wedge of omentum Wound closed with drain to the site of the tear She died March 5, 1926, of peritonitis, mediastinitis and pericarditis, due to a leak at the suture line

At autopsy there was found a large ragged hole in the œsophagus extending three centimetres above the diaphragm Sections showed an ulceration of edges and extensive inflammatory infiltration

Doctor Rake has examined sections and reports findings in accordance with those described in his publication Microphotographs are shown in Figs 9 and 10

CASE II—Miss K B, aged fifty years Admitted November, 1926, complaining of pain and difficulty in swallowing, regurgitation of food and loss of weight Onset of symptoms five years ago, with difficulty in swallowing and pain in the lower end of the sternum Difficulty gradually increased until unable to swallow any food without pain and great difficulty She takes from one to two hours to a meal, and eats alone because, in her efforts, food is as likely to regurgitate as to go down She takes fluid till the œsophagus feels full, then holds the nose, takes a breath, throws back her head and forces down She accompanies the meal with large quantities of water

X-ray examination, plate 2, shows marked dilatation of the œsophagus, with only small quantities passing down the œsophagus A drink of barium and water passed more readily

She had been under medical treatment for varying periods Had had atropine and dilatation with hydrostatic bag dilator Had had periods of tube feeding and had learned to pass stomach tube herself

An œsophagoplasty was done November 15, 1926, Marwedal incision The subdiaphragmatic portion of the œsophagus was found to be a small round cord about one-half inch in diameter The hiatus was enlarged by cutting forward and to the right The dilated portion of œsophagus brought down for nearly two inches and



sutured to the edge of the enlarged hiatus. It was fully two inches in diameter at this point. The abdomen was closed without drainage.

From the time of the operation till the present, she has been able to swallow food normally, provided it is finely divided and well mixed with water. She has regained her weight and strength.

X-ray plates (Fig 5) show the fluoroscopic picture nearly four and one-half years after operation.

The œsophagus has regained a nearly normal size, but still requires a 6-inch head of fluid column before food enters stomach.

**CASE III**—Mrs B McD, aged fifty-eight years, May, 1926. Difficulty in swallowing began about one year ago, more with solids than liquids. Takes food till she feels full up. Then by forceful efforts works the food down. Sometimes during these efforts she regurgitates. She then rests, fills the œsophagus again and again forces it onward. The œsophagoscope reveals a dilated thoracic œsophagus and a closed cardia which was found to grip around a bougie.

Since 1926 she has had more and more difficulty in swallowing, with regurgitation of food. In December, 1928, contracted influenza and was extremely ill, and could swallow no food. At this time tube feeding was instituted. She quickly learned to pass her own tube and has continued ever since. She has lost 80 pounds in the past three years.

**Operation** May 29, 1929. Œsophagoplasty. Marwedel's incision. The subdiaphragmatic portion of the œsophagus was found to be about 2 centimetres in diameter. The wall was not thickened. The opening in the diaphragm was enlarged, the dilated portion of the œsophagus brought down. At this point it was 2 inches in diameter and not notably thickened. In order to bring it down the right vagus was cut. Immediately following operation she was able to swallow normally and she has continued to be able to do so. No films available.

**CASE IV**—J S, aged fifty-eight.

*History of the present illness*—About one year previous to the operation he began to suffer difficulty in swallowing and what he took to be vomiting.

The onset was sudden but the course intermittent. Gradually the difficulty in swallowing became more severe and he regurgitated quantities of food mixed with mucus.

*Personal history*—The patient has been known to be diabetic for five years. The diabetes in moderate degree requires to take insulin. He used alcohol to excess. The Wassermann was negative.

**Operation**—Marwedel's incision. The subdiaphragmatic portion of the œsophagus was found to be about three-quarter inch in diameter. The hiatus was enlarged, the œsophagus freed and brought down 2 inches below the diaphragm. At this level the dilated portion was about 2 inches in diameter, the wall definitely thickened. The right vagus nerve and a branch of it were cut to allow the œsophagus to be brought through. Sutured to the edges of the opening.

Following this he swallowed liquid food freely. X-ray before leaving hospital shows the œsophagus as before, but when the head of fluid reaches about half way up the chest fluid begins to enter the stomach.

He returned home and was well until he had a violent attack of vomiting lasting three days. Reentered the hospital.

He vomited large quantities of coffee ground vomitus when taking no fluid by mouth. Stomach washing demonstrated that the vomitus was from the stomach and that fluid entered the stomach.

His blood sugar rare and he showed acetone in urine. Under the control of the diabetes and stomach washing the vomiting gradually ceased and he began to take food again. X-ray plates 3 and 4 demonstrate the condition of the œsophagus still dilated.

but fluid enters stomach under the pressure of a head of fluid of 6 inches Water following the meal carries it through

He lives on finely divided food mixed with fluid and followed by water

DISCUSSION—DR LEONARD FREEMAN (Denver, Colorado) said there seems to be two forms, or two reasons why swallowing is difficult in dilatation of the œsophagus One is the fact that it is a cardia spasm, and the other is the fact that the cardia seems to be too long for the room in the chest allotted to it so it becomes convoluted And the difficulty in swallowing is not always due to the fact that the cardia spasm is present, because it is not at all present in these cases Kummell has called attention to some where the mere fact that the length of the œsophagus was convoluted, prevented swallowing

Any muscle that has not any proper point of attachment, or that is too long for its point of attachment, does not work properly That opens up the idea that Doctor Scrimger has so accentuated, that the œsophagus may be shortened by pulling it down into the abdominal cavity, or, as first suggested by Pribram but not carried out by him, it may be shortened by pulling it up into the neck

In 1923 the speaker read a paper on that subject before this Association in which he recounted the results of an operation he did in 1902, twenty years before, upon a man who was unable to swallow because of a supposed cardia spasm He cut down the neck and found a dilatation of the œsophagus By passing the finger into the thorax through the wound in the neck, he was able to loosen the œsophagus, and then he pulled it up into the neck, getting perhaps a fold of œsophagus that was 2 or 3 inches in length After reflection he decided to invaginate the upper end of the œsophagus into the lower This he proceeded to do, thus shortening the œsophagus and reducing the cardia over that portion that was invaginated He then closed the wound in the neck

It was a simple operation No infection—it healed nicely The man was relieved immediately That relief lasted for twenty years It would seem that if one adopts this method of shortening the œsophagus that it is easier and simpler to do from a wound in the neck and invaginating the œsophagus into itself, than to do it from an elaborate wound and attempt to pull the œsophagus down into the abdominal cavity

DOCTOR SCRIMGER rejoined that the very severe case is produced by the kink The mechanics of the diaphragm present a picture quite different in a lesser degree of severity, where the œsophagus comes down to a long point at which, as it fills up, there is a steady trickle that goes into the stomach In the severe cases, where the œsophagus has elongated over into the diaphragm, the more you put into it, it seems, the more it is obstructed Bringing down the œsophagus through the diaphragm is quite easy The approach is made very simple by the so-called Marwedel incision, turning down the left side of the liver, and then the œsophagus can be brought up to the wound, as can the pyloric end of the stomach

## THE PYLORIC SPHINCTER AND DUODENAL ULCER

BY JOHN B. DEAVER, M.D. AND VERNE GERARD BURDEN, M.D.

OF PHILADELPHIA, PA.

CHRONIC duodenal ulcer continues to occur without explanation or apology, and when we try to investigate its associated phenomena we find new wonders. The incidence of ulcer is increasing and we know of no preventive measures. All is not serene among those who treat the disease. It may get well without any treatment, but of this we have grave doubt particularly as it applies to chronic ulceration. Medical treatment undoubtedly can control symptoms but in our experience recurrence follows remission of treatment in the same fashion it does in the natural course of the disease with the exception that the period of absent symptoms is longer. Once established there seems to be an inherent tendency to duodenal ulceration or to the underlying disturbance of which it is a sequel, so that, for a time, it may be held in abeyance, but reactivity of the lesion is resumed when the methods of control are withdrawn. The results of surgical treatment in competent hands have been highly satisfactory. The selection of patients for operation plays a large part in beneficial results. Gastro-enterostomy for chronic duodenal ulcer especially in the presence of obstruction is one of the most satisfactory operations in surgery. Improved diagnostic methods, especially the X-ray and the widespread familiarity with the symptoms of ulcer have led to earlier recognition. Today, duodenal ulcer is operated on earlier by many surgeons and before the proverbial nine medical cures. The results in these early cases from gastro-enterostomy are not so highly satisfactory and the immediate good results seem to diminish as the post-operative period lengthens. The reason for this we do not know. Its investigation may uncover important therapeutic facts. We suspect that in these early operated ulcers with unsatisfactory results the state of pathologic physiology of which ulcer is a sequel is a temporary affair, which, when it spontaneously rights itself leaves the patient with an unnecessary gastro-enterostomy. The latter then may give rise to digestive derangements and symptoms and actually may favor the development of a marginal ulcer. Medical treatment has its value. When properly and faithfully followed, it may, in many cases, control the condition until the tendency to ulceration disappears. The difficulties as we see them are that by no method can one select and eliminate the candidates for chronic duodenal ulcer and any process of selection by medical treatment must face the dire hazards of perforation and hæmorrhage. We cannot see the wisdom of partial gastrectomy for duodenal ulcer. We admit that the indiscriminate use of gastro-enterostomy for every case of duodenal ulcer produces results which leave the surgeon in a position difficult to defend. Gastro-enterostomy occupies a conservative surgical position. Within the last four

years we have become more conservative but we still adhere to our belief that by means of operation the welfare of the patient is best served and safeguarded. In this time we have practiced a new surgical procedure but have not discarded gastro-enterostomy, which we reserve for those patients in whom certain definite indications are present only when the lesion is exposed at operation. There are certain striking differences between the functional behavior of the normal stomach as compared with the stomach of an individual who has a duodenal ulcer. The latter may be called pathologic physiology. It is generally ascribed to the disturbing influence of the ulcer. It gives rise to characteristic symptoms by which ulcer is recognized. We have adopted the view that such symptoms antedate the appearance of ulcer and that they signify a derangement of function of which ulcer is a sequel. The chronicity of ulcer and its tendency to recur after periods of remission depends upon the maintenance of perverted gastric function.

The secretory activity of the stomach is so adjusted that the quantity of gastric juice is directly proportional to the quantity of food, and the juice as it flows from the glands possesses a constant acidity. In the words of Pavlov "The astonishing exactitude of the work of the glands that which is demanded of them they furnish each time to a hairbreadth, no more and no less." In this normal scheme of things there is no necessity for a neutralizing mechanism to take care of excess acid since the juice, as it comes from the glands, has a constant acidity, about 0.5 per cent, and only enough is produced to maintain an optimal digestive concentration in the food mixture.

The stimuli for the secretion of acid originate from two separate sources. One, the more important, is the psychic stimulus which is initiated by the sight, smell, or taste of food. It gives rise to an outpouring of so-called appetite juice which is highly potent in digestive properties. This stimulus has been proven to reach the gastric glands by way of the vagi nerves. Pavlov showed that dogs in which the vagi are cut high up will not produce gastric juice after sham feeding. "Appetite spells gastric juice." The other stimulus, the lesser of the two, comes from the presence of food in the stomach.

Variations above normal in gastric secretion are most likely to ensue when the psychic stimulus is overactive or unduly prolonged beyond digestive requirements. The excessive acid so produced must be controlled by neutralization first, in order that digestion can proceed, and second to avoid injurious effects of highly concentrated acid on the gastric mucous membrane. Temporary and slight degrees of excessive acidity are probably controlled by an outpouring of mucus. However, the mucus of the stomach has only weak neutralizing properties. The pyloric mechanism is the main factor for control when for any reason gastric acidity shows a tendency to exceed normal limits. It seems more in keeping with facts to speak of the pyloric control of acidity rather than of the acid control of the pylorus. The pyloric sphincter in coordination with reverse peristalsis in the duodenum, upon demand, provides for regurgitation of duodenal contents into the stomach. This fluid, composed mainly of pancreatic juice, is the most alkaline in the body. Many

investigators have confirmed the finding of Boldyreff that duodenal regurgitation occurs so commonly that it may be called a natural phenomenon

Thus, it would seem that the normal stomach under normal control produces a quantity of acid which is accurately regulated in keeping with digestive requirements and when, as the result of overacting stimuli, an excess of acid is formed the control mechanism of duodenal regurgitation provides the factor of safety

Quincke in 1889 observed a child with a gastrostomy and noted that during fasting the pylorus often remained open for ten minutes during which time bile and other intestinal fluids passed to and from the stomach This so-called duodenal regurgitation was later studied by Boldyreff who concluded that it was a natural phenomenon and ascribed to it a regulatory rôle in the control of gastric acidity The observation of Boldyreff has been widely confirmed and generally accepted but his theory as to the natural control of gastric acidity has been questioned by the results of recent experiments The latter hold to the view that the normal stomach has an inherent ability to control its own acidity But the stomach of an individual with duodenal ulcer does not exhibit normal function and there is a notable failure to control acidity If what Pavlov states is true regarding the secretory behavior of the stomach, then the state of hyperacidity must result from an overproduction of acid, that is, beyond or independent of digestive requirements combined with failure of some mechanism whose purpose is the control by neutralization of excess acid A number of investigators have made experiments on duodenal regurgitation in dogs by introducing into the stomach 200 cubic centimetres of 0.5 per cent hydrochloric acid They found that the regurgitation of duodenal fluid into the stomach is a constant occurrence and that the rate of neutralization of gastric acidity can be accurately measured That antiperistalsis in the duodenum is the force behind regurgitation is indicated by the X-ray studies of Salmond In 100 consecutive human cases he observed antiperistalsis in the duodenum in ninety-three The actual regurgitation through the pylorus into the stomach he has been able to see in some twenty odd cases but this, he states, is difficult to detect Intragastric pressure is normally below 10 centimetres of water while duodenal pressure is between 10 and 15 centimetres of water In their clinical studies, Wright and Medes found that regurgitation of duodenal contents into the fasting stomach occurred in 100 per cent of the cases and that it took place with special frequency as the stomach is emptied The purpose of regurgitation obviously is to neutralize excess acid and in the process the pancreatic juice is the main factor Hepatic bile is neutral in reaction and usually acid before reaching the intestines

The division between stomach and duodenum is sharply defined anatomically and physiologically by the pyloric sphincter Formerly it was thought that this muscular ring had much to do with the emptying of the stomach but in this it actually plays a small part unless by dysfunction or fibrous contraction a functional or mechanical obstruction exists

Text-books of anatomy refer to the pylorus as a local increment of circular muscle fibres. The importance of the pyloric sphincter as a separate anatomic and physiologic entity recently has received recognition. About five years ago when we became interested in the relationship between the pyloric sphincter and peptic ulcer one of us made dissections of the human stomach by removing the mucosa and submucosa. Observation of the exposed muscular coats demonstrated that the pyloric sphincter was a distinct muscular ring. In other dissections we found that the sphincteric muscular ring could be peeled off readily from the underlying submucosa to which it was only loosely attached. A true sphincter not only has the ability to contract, which is its most generally accepted function, but also to undergo active dilatation. In 1879 Rudinger described the dilator muscle of the pylorus, and Forrsell said that the pyloric sphincter has radial and circular muscle fibres which like the iris can diminish the lumen of the tube-shaped canal. The recent studies of Horton have been most interesting. He demonstrated that at the pylorus 50 to 55 per cent of the longitudinal fibres which are continued down from the stomach, dip into the pyloric sphincter to take part in the formation of the sphincter and constitute the dilator muscle of the pylorus. The circular muscle fibres of the pylorus constitute four or five times more of the thickness of the sphincter than do the longitudinal fibres. From his studies he concluded that the pyloric sphincter is a complete sphincter, in which there is both a constrictor and dilator mechanism.

If it be true that the pyloric sphincter has a dual opposed musculature like a true sphincter then for purposes of coordinated function it must possess a double innervation whose nerve fibres cannot be solely vagal or sympathetic in origin but the innervation of the circular fibres must be derived from a source other than that for the dilator fibres. Researches on the innervation of the pyloric sphincter have not yielded concordant conclusions. For the ileocaecal sphincter, Elliott showed that the sympathetic is for contraction and the vagus for relaxation. In the general musculature of the stomach the vagus is motor. Since the only part of the pyloric sphincter formed from the general musculature of the stomach is by the longitudinal fibres which dip in to form the dilator muscle it seems logical to infer that vagal stimulation, unless too strongly opposed by contraction of the more powerful circular fibres, should cause active dilatation of the pyloric sphincter. The circular fibres of the sphincter are independent of the musculature of the stomach. In fact, according to Gaskell, the sphincters of the gastro-intestinal tract do not have a common origin with the enteric musculature but represent isolated remains of epidermal musculature. In accordance with this developmental theory Gaskell believed that the motor nerves for the constrictor fibres of the gastro-intestinal sphincters were derived from the true sympathetic nerves of the thoracico-lumbar outflow from the spinal cord. Carlson and Litt in the course of their studies on the reflex control of the pylorus state that mechanical or electrical stimulation of any visceral afferent nerve may induce a temporary spasm of the pylorus and that these reflexes persist after section of both vagi in the neck.

Therefore, it would seem that the main efferent paths are in the splanchnic nerves. They found that epinephrin (whose specific action is only on structures supplied by true sympathetic nerves) induces contraction of the pylorus. They conclude that the predominant reflexes from the viscera into these sphincters (cardiac and pyloric) under their experimental conditions, is motor, and if prolonged they became cardiospasm and pylorospasm.

From a study of the work of the above investigators we believe there is evidence to indicate that the constrictor fibres of the pyloric sphincter are supplied by the sympathetic and the dilator fibres by the vagal nerves. It also seems well established that regurgitation of duodenal contents into the stomach is a natural phenomenon whose purpose it is to neutralize gastric acidity when the latter for any reason is produced in excess of digestive requirements. The pyloric sphincter by its strategic position presides over and controls the mechanism of duodenal regurgitation.

Hyperacidity by which we mean a real excess of hydrochloric acid can arise only from an overactivity of the stimulus which produces normal acidity. The main pathways for this stimulus are the vagus nerves since section of these nerves produces a permanent reduction in gastric acidity. Temporary hyperacidity probably is of frequent occurrence and its control is by the safety mechanism of duodenal regurgitation. One of the characteristics associated with duodenal ulcer is persistent uncontrolled hyperacidity. By means of the acid-test meal, patients with duodenal ulcer have been shown to have inadequate or absent duodenal regurgitation. For this the fault seems to lie with the pyloric sphincter which through failure to open (achalasia) or because of spasm acts as a hindrance to the needed reflux of duodenal contents into the stomach. Is this disturbance of function secondary to and caused by the presence of duodenal ulcer? According to the views expressed by Hurst, the answer is in the affirmative. He also explains the symptomatology of ulcer on the basis of dysfunction of the pyloric sphincter. We are in agreement with the latter view but on the basis of our clinical experience and the researches of others we hold that the symptoms precede the appearance of ulcer and that such symptoms are the expressions of a disturbed physiology of which ulcer is a sequel. Every surgeon many times has had the experience of operating on a patient who exhibited the characteristic symptoms of ulcer but no ulcer by a most thorough search could be demonstrated. Such instances particularly occur when the history of ulcer has been one of short duration. These symptomatic ulcers are often cured by medical measures. Little wonder that Moynihan was led to remark "The ulcer that cannot be demonstrated to the entire conviction of the onlooker does not exist." To the detriment of surgery we must admit that symptomatic ulcer has often been treated by gastro-enterostomy. In these cases we have many times found the lesion in the appendix.

Most of the older work on the experimental production of peptic ulcer can be discarded. In our opinion the experiments of Mann by which he regularly produced typical peptic ulcers in dogs by his method of surgical duodenal drain-

age establish beyond doubt the importance of acid as the paramount etiologic factor. In these experiments there are two other significant points. The ulcer did not occur in the duodenum but in the proximal end of the transplanted jejunum and the acidity of the stomach as shown by McCann remained unchanged. These findings indicate that acid is the main etiologic factor in the production of ulcer, that in the jejunum under the conditions of the experiment an ulcer may result from the action of normal gastric juice and that duodenal regurgitation normally is not required for the control of gastric acidity again confirming the views of Pavlov on the exactitude of gastric secretion. The experiments also do much to explain the occurrence of secondary ulceration after gastroenterostomy since this operation may permit unmodified gastric juice to come into direct contact with the jejunum.

Weiss and Gurian cut the duodenum across below the exit of the bile and pancreatic ducts. The proximal end was united to the side of the lower ileum thus diverting the duodenal contents. The pylorus was then divided and the duodenal opening closed by suture. The efferent loop of the duodenum after the first step of the operation was united end-to-end to the pylorus. In each of the fifteen dogs so treated a typical chronic, sometimes perforating, ulcer developed in the duodenum several centimetres below the anastomosis. In these experiments they also found, as did McCann, that there was no change in gastric acidity from the pre-operative figures. In their opinion gastric acid is the chief etiologic factor in the development of ulcer and duodenal regurgitation is a protective mechanism which not only saves the mucous membrane from the harmful effects of hyperacidity but it also gives the needed protection against normal acidity. How does this experimental work apply to the human subject? Duodenal regurgitation occurs with such regularity in the normal stomach as to be considered a natural phenomenon. In patients with duodenal ulceration it has been demonstrated that regurgitation is either absent or deficient. Ulcer is not the cause of symptoms because typical symptoms so frequently occur in the absence of ulcer and during periods of symptomatic remission the ulcer is still present but is in a process of healing which has been verified by careful histologic studies although completely healed ulcers are extremely rare at the operating table. Those who have studied the progress of ulcers under medical treatment report that symptoms do not disappear until pylorospasm has been relieved. In the opinion of Hurst, with which we agree, the symptoms of ulcer are an expression of dysfunction of the pyloric sphincter. Gastroenterostomy is an experiment in physiology. In this operation the surgeon unknowingly puts to test the theory that acid is the chief etiologic factor in ulcer. The subsequent development of a marginal or jejunal ulcer is evidence of the fact that the jejunum is vulnerable to the action of normal or hyperacid gastric juice. If the anastomotic stoma is insufficient in size or develops a sphincteric mechanism it may prevent the entrance into the stomach of the neutralizing duodenal contents so that unmodified or hyperacid gastric juice is ejected directly into the jejunum where an ulcer develops at the site of contact as it did in the



duodenum When a gastroenterostomy is made following the appearance of the ulcer after Mann's surgical duodenal drainage the original ulcer promptly heals but a new ulcer usually develops in the jejunum opposite the anastomosis In patients with duodenal ulcer treated by gastroenterostomy and in whom symptoms were relieved Flman showed by means of the acid test meal that there was prompt and efficient neutralization of the acid

It is our belief that in the development of duodenal ulcer two etiologic factors are at work, neither of which can cause the ulcer without the cooperation of the other One is hyperacidity by which we mean an overproduction of acid The other is spasm or achalasia of the pyloric sphincter Hyperacidity no doubt occurs periodically in many individuals who never develop duodenal ulcer for the reason that they have an efficient safety mechanism in duodenal regurgitation Likewise pylorospasm must be of frequent occurrence in many individuals particularly in those who harbor an intra-abdominal focus of infection In these we often find the symptoms without the ulcer But when there occurs the combination of the two factors, that is, hyperacidity and pylorospasm, the offspring of this mating is ulcer We do not know the cause of hyperacidity The stimulus which produces it comes down the vagus nerves It is an exaggeration of the appetite or psychic phase of gastric secretion Less do we know of means to control it Perhaps complete mental and physical rest is the answer Indeed, patients with duodenal ulcer often experience complete symptomatic relief when they are able to obtain physiologic rest It is an important part of the medical treatment of ulcer But life must go on and such treatment cannot be followed indefinitely We know that pylorospasm is often a reflex from an intra-abdominal irritation In this way chronic appendicitis or cholecystitis, the two most common foci of infection within the abdomen, may under proper conditions play a large part in the etiology of ulcer Pylorospasm may also occur as a part of a general nervous disturbance which particularly affects structures supplied by sympathetic nerves and is manifested by sympathetic overactivity The work of Crile along this line deserves serious consideration He has advocated and practiced resection of the suprarenal glands for the cure of duodenal ulcer Many observers have noted that duodenal ulcer usually selects for its host an individual of a characteristic constitutional type

The active treatment of duodenal ulcer when carried out along rational lines especially with regard to etiologic factors to be successful, must attain one important result namely, the control of hyperacidity In what better way can this be done than by restoration of the natural mechanism for neutralization? This may be accomplished in an indirect manner by gastroenterostomy The results of this operation are not uniformly satisfactory when based on the experience of many surgeons Careful selection of patients will improve the surgical results but what is to be done for those patients who fail to qualify for operation? Must they serve an apprenticeship under medical treatment before being admitted to the operating room?

Many surgeons hesitate to recommend operation when the history of

ulcer has been of short duration. Perhaps this is based on sound judgment because in such cases the results of gastroenterostomy have not been creditable. Operation in many early cases has disclosed symptomatic ulcer. Nowhere in surgery has the unquestionable evil of an operative procedure been established as in the case of gastroenterostomy for the symptoms of ulcer without a demonstrable lesion. Experimental ulcers develop within six weeks to two months. Perhaps in the human subject this period is longer. In clinical experience it is not uncommon to have symptoms of secondary ulceration develop within two or three months after gastroenterostomy. We have seen many cases of acutely perforated duodenal ulcer with a history of only several weeks' duration. From a pathologic standpoint, and this coincides with clinical facts, a duodenal ulcer of several months' duration carries the same hazardous complications of perforation and hæmorrhage as does an ulcer of years' duration.

The obvious fact in the etiology of ulcer is that the causative agent not only initiates the lesion but is responsible for its chronicity. We believe that the causative agent is excessive gastric acidity which through failure of the mechanism of neutralization exposes the duodenal mucous membrane to the injurious effects of acid. The hindrance to duodenal regurgitation in cases of ulcer is the abnormal action of the pyloric sphincter. The test of the correctness of this theory should be the results in patients with ulcer in whom the activity of the sphincter has been abolished.

The technic of the operation has been previously described. In simple terms it consists of the submucosal removal of the anterior half of the pyloric sphincter. The procedure while necessitating meticulous attention to the details of dissection can be completed in ten minutes. There should be no mortality. The final result does not disturb the normal anatomic relationships. The sphincter is put completely out of commission because one-half of it is removed. Simple cross-section of the sphincter as in the Ramstedt operation in our opinion does not permanently abolish sphincteric action. Plastic operations on the pylorus in which the lumen is deliberately opened eventually may lead to cicatricial stenosis. By removing half of the sphincter without opening the lumen scar tissue is reduced to a minimum, stenosis does not occur and the sphincter is rendered inactive through loss of half its substance and interruption of nerve pathways. In our practice the operation is performed in every case of duodenal ulcer, unless certain conditions make it technically impossible to do so. These conditions have to do with a firmly fixed pyloro-duodenal area which make it inaccessible for the operative manoeuvres. Excessive scar tissue or periuicerous exudate are technical contraindications. In such instances we perform gastroenterostomy. In several cases of acutely perforated duodenal ulcer we have closed the perforation and then removed the anterior half of the sphincter.

*Results*—In our early experience before perfection of technic we committed such errors as accidental opening into the duodenum and failure to

remove completely all the muscle fibres in the anterior half of the sphincter. These errors have an effect on the post-operative results.

During the years 1928, 1929, and 1930, ninety-one patients with duodenal ulcer were operated on. Forty-four of these were treated by removal of the anterior half of the pyloric sphincter. In addition to the operation for ulcer, in many cases coincident lesions as appendicitis and cholecystitis received operative attention. This report concerns the forty-four patients who had a demonstrable duodenal ulcer and in whom the anterior half of the pyloric sphincter was removed. Four patients died in the hospital, one from respiratory failure three days after operation, one from uræmia ten days after operation, one from cardiac disease thirteen days after operation and one from peritonitis thirteen days after operation. Of the remaining forty patients, thirty-five were seen and examined at regular intervals in the follow-up service of the Lankenau Hospital over a period varying from two months to three and one-half years after operation. The examinations were made by members of the hospital staff. Results of the examination were graded from one to four. A patient who had complete relief of pre-operative symptoms was graded four while one who experienced little or no relief was graded one. On this basis, twenty-six patients were graded four, five were graded three and four graded two. It was noted that the improvement or relief of symptoms did not diminish as the post-operative period lengthened.

Fluoroscopic examination of the stomach after an opaque meal was made in sixteen patients during the course of the observations in the follow-up service. In all patients it was noted that the emptying time was normal or slightly accelerated although in many of these the pre-operative study had shown delayed emptying or actual retention. It was difficult for the roentgenologist to give a definite opinion regarding direct signs of ulcer in the duodenal cap because of the confusion arising from the proximity of the operative site. In all patients except three the indirect signs of ulcer had disappeared. Post-operative gastric analysis by means of the fractional test was carried out in a sufficient number of patients to determine that there was no significant change from the pre-operative findings. We do not attach much importance to these results for the reason that the usual fractional analysis after a test meal gives little positive information regarding duodenal regurgitation and the actual concentration of acid entering the duodenum. Important evidence regarding the efficacy of the operation on the sphincter in restoring duodenal regurgitation could be obtained by means of the acid test meal. This we have not done but propose to do it in future cases. At the present stage we can only say that regardless of laboratory studies the operation has given symptomatic relief.

*Conclusions*—It seems that duodenal ulcer usually occurs in individuals who have a constitutional hyperacidity. From experimental and clinical studies it seems that acid is the direct causative factor in the initiation and maintenance of duodenal ulcer. That all individuals with temporary or persistent hyperacidity do not develop ulcer is probably due to the safety control mechanism.

## PYLORIC SPHINCTER AND DUODENAL ULCER

of duodenal regurgitation. Studies have shown that patients with ulcer have deficient duodenal regurgitation or are unable to neutralize efficiently acid injected into the stomach. The clinical symptoms of ulcer can be explained on the basis of pylorospasm. Dysfunction of the pyloric sphincter not only causes the symptoms of ulcer but precedes the appearance of ulcer. The combination of dysfunction of the pyloric sphincter and hypersecretion of acid gives rise to duodenal ulcer. The control of the hypersecretion of acid is difficult and uncertain by medical means alone. The other factor, the pyloric sphincter, in the etiology of ulcer can be removed by a surgical procedure. Removal of the anterior half of the pyloric sphincter by the method described permits uninterrupted regurgitation of duodenal contents into the stomach thereby attaining control of acidity. This operation does all that gastroenterostomy can do and all that medical treatment tries to do. It restores nature's method for the control of acidity. It is based on sound physiologic principles. It is generally agreed that when gastric acidity is controlled a duodenal ulcer will heal and that symptoms will disappear when pylorospasm is relieved. The operation on the sphincter accomplishes both objectives. The advantages of the operation are, its simplicity of performance, there is no disturbance of anatomic relationships and there is no opportunity for the development of anastomotic ulcer. In our practice, submucosal removal of the anterior half of the pyloric sphincter is the operation of choice for duodenal ulcer. Certain contraindications are stated. Results are given in forty-four patients with duodenal ulcer in whom the anterior half of the pyloric sphincter was removed.

## HÆMANGIOMA OF SIGMOID AND COLON

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HÆMANGIOMA of the large bowel is a relatively rare disease. Nevertheless the mortality has been so high and the operative results so unsatisfactory that the report of a case with a satisfactory cure seems justified. In the case to be reported the area of the tumor corresponded to the distribution of the superior hæmorrhoidal vein. Assuming that there would be a free venous communication between the vein and the dilated areas of the tumor, a plan was devised for obliterating the venous sinuses—with resultant cure. The details of the operative procedure, colostomy and later closure of the colostomy are described in the case report in the latter part of this article.

A search of the literature for hæmangiomas of the colon show few reported cases.

The end-results of these cases showed that death occurred from hæmorrhage, or resection or permanent colostomy were performed to relieve the symptomatology. As the disease is usually congenital, the symptoms of bleeding occur in early life, and as a result the normal activities of youth are restricted and the outcome is indeed tragic.

*Pathology*—If one accepts the theories propounded by Virchow, Ribbert, and Fraser that hæmangiomas are localized encapsulated tumors it is questionable whether one can definitely classify the vascular tumors seen in the large bowel under the terminology of hæmangioma.

Ribbert, working on cavernous angiomas with particular reference to the small telangiectatic tumors of the skin and the cavernomas seen in the liver, states that the tumor, consisting of vessels with thin walls surrounded by a connective tissue stroma containing few cells, has no direct connection with the capillaries of the normal surrounding tissue. There is no interconnection with the surrounding vessels, no indication that the dilated lumina gradually contract to merge with the capillaries or possibly have developed from them. This impression, according to Ribbert, is absolutely not changed by the fact that arterial vessels enter while venous vessels emerge from angioma or that individual sections demonstrate this communication. Ribbert also says that there is no justification for assuming that originally the vessels of the hæmangioma were the normal part of the vascular system and developed later into a tumor. He believes that the vascular complex producing the new growth was an independent entity from the beginning and not a preëxisting dilatation of normal vascular channels. Virchow, Rindfleisch, and Ribbert believe that cavernomas are due to the primary development of connective tissue infiltrating the surrounding tissues gradually without any distinct mi-

microscopic visible formation. The vessels are subsequently formed within this connective tissue. Ribbert injected the vessel walls of angiomas of the skin and of cavernomas of the liver and was able to show that the injected solution was seen exceeding the limits of the tumor only where arterial vessels entered it and venous vessels emerged from it. There was no direct connection between the capillaries of the tumor and the surrounding capillaries of the host.

Fraser states in congenital hæmangiomas these vessels are originally formed in the vascular areas of the mesoderm of the embryo. Certain cells of the mesoderm (angioblasts) become vacuolated, and proliferate in such a way as to form a syncytium. Fluid collects within the vacuoles, which, enlarging and proliferating, give rise to minute reddish specks, the so-called "blood islands of Pander." The enlarged parts of the syncytium are united to one another by narrower parts, and after a time the cavities extend into the narrow portion, so that a network is produced. The walls of these primary vessels are composed at first merely of the protoplasm of the syncytium, with nuclei embedded in it here and there. Subsequently, the protoplasm becomes differentiated around the nuclei into the flattened cells which compose the walls of the capillaries, and which form the lining walls of the arteries and veins. As they are developed, the vessels are backed by a very slight amount of connective tissue which forms a stroma that binds them together. Sometimes the stroma is abundant, so that the tumor appears more or less scirrhous-like in type.

*The Further Evolution of the Tumor* \*—There are at least four possible and different directions in which the evolution of the tumor may occur: (1) Its growth may become arrested, the tumor eventually undergoing spontaneous cure by a process of fibrosis, (2) the tumor, while retaining the characteristics of a capillary hæmangioma, continues to grow by a process of infiltration of the surrounding parts, (3) the original capillary type of hæmangioma becomes converted into a cavernous type of hæmangioma, (4) the original capillary type of tumor becomes converted into what we have termed the compact type of hæmangioma.

1—*Natural Arrest and Spontaneous Cure*—The connective-tissue stroma which, in greater or lesser quantity, always surrounds the tumor elements, is converted into a dense fibrous tissue. By a perivascular and endovascular thickening, the blood-vessels undergo a progressive obliteration. The diminished blood-supply, and the pressure of the surrounding fibrous tissue, eventually lead to a complete disappearance of the tumor tissue, its position being replaced by fibrous tissue.

2—*Progressive Spread and Infiltration*—Infiltration is extensive in the subcutaneous fatty tissue, the tumor extending between individual fat cells, and among the fibres of the connective-tissue stroma. The deeper the examination is carried, the less marked does the infiltration become. To some

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\* Fraser, John. Hæmangioma Group of Endothelialblastomata. *British Journal of Surgery*, vol. vii, p. 335, 1929-1930.

extent infiltration occurs in muscle, the tumor extending between individual muscle fibres. Where nerves are present the sheath of the nerve is invaded, and there is a spread inwards between individual nerve fibres.

3—*The Development of the Cavernous Type of Hæmangioma*—If the embryonic capillary tissue develops a connection with the circulation, the cavernous type of hæmangioma may result. The original embryonic capillary vessels become distended, probably from the passage through them of the circulating blood under some degree of pressure. The lining endothelium becomes very much thinner, and the cavity is filled with blood, which, judging from the character of its corpuscular elements, is in active circulation. In this last respect the contents of the cavernous hæmangioma differs very markedly from that of the capillary type, the corpuscular contents of which are either imperfectly developed or degenerated. It is the exception to find a tumor in which the cavernous change has become general, in almost every instance, if the cavernous tumor is present, it is associated with the capillary type, and with varying changes in transition between the two.

4—*The Development of the Compact Type of Hæmangioma*—If, for some reason, the endothelial cells lining the capillary type of tumor take on active proliferation, the compact type of hæmangioma may develop. Generally the proliferation is perivascular in type, occasionally it is endovascular, the cells projecting in papilla-like arrangement, and becoming arranged in concentric masses and whorls. The development of the compact variety of hæmangioma is accompanied by a localization of the tumor.

In our case, where no specimen was removed for examination, it is difficult to state whether or not the diffuse cavernous dilatation of the vessels was in truth a tumor growth or a dilatation of existing vessels. As can be seen in the illustration there was no sharp demarcating line between the angioma and the normal bowel. Throughout the area of about an inch and a half there was a gradual transition from dilated to normal vessels. Also it was obvious that there was a free, open communication between the superior hæmorrhoidal vein and the dilated vessels within the lumen and on the surface of the affected colon.

*Symptoms*—As can be seen in Chart I the most prominent symptom in the cases reported is repeated bleeding from the rectum, often beginning in infancy. As a result, a true anæmia occurs, frequently associated with asthenia and cachexia. The hæmorrhages may be small, or sufficiently massive to cause exodus. In a number of cases hæmorrhoidectomy has been performed without satisfactory cure. In one case intestinal obstruction was created by a pedunculated submucous angioma.

#### SUMMARY OF REPORTED CASES

CASE I—Reported by Barker, 1883, male, forty-five years of age. Symptoms—Diarrhœa with hæmorrhage, occasional constipation. Duration—"Since boyhood." Treatment—Injections of Tr. Fer. Perchlor. Rest in bed. Results—Death. Nævroid growth in lower rectum.

## HÆMANGIOMA OF SIGMOID AND COLON

CASE II—Reported by Marsh, 1883, female, ten years of age Symptoms—Repeated hæmorrhage from bowel Duration—Since age of two Treatment—Cauterization Results—Relieved symptoms but did not cure growth

CASE III—Reported by Benneke, 1906, male, fifty-two years of age Symptoms—Not stated Died of tubercular meningitis Duration—Not stated Results—Post-mortem examination hæmangioma of entire intestine

CASE IV—Reported by Tuffier, 1913, male, thirty-one years of age Symptoms—Intestinal hæmorrhage and anæmia Duration—Seven years Treatment—Cauterization, later operation Results—Death after laparotomy

CASE V—Reported by Hartmann, 1913, female, twenty-two years of age Symptoms—Rectal hæmorrhage Duration—Not stated Treatment—Cauterization Results—Recovery

CASE VI—Reported by Kausch, 1914, male, seventeen years of age Symptoms—Blood in stool, hæmorrhage and anæmia Duration—Since first year Treatment—Operated in fourth year for congenital hæmorrhoids Hosp tr 1911-1912, artificial anus, removal of polyp from anus 1913-1914, five-stage operation Results—1916, general condition greatly improved

CASE VII—Reported by Dujarier and Topous Khan, 1920, male Symptoms—Intermittent rectal hæmorrhage, anæmia, loss of flesh Duration—Three years Treatment—Exploratory laparotomy Results—Not stated

CASE VIII—Reported by Hennig and Schutt, 1923, male, twenty-three years of age Symptoms—Rectal hæmorrhage, blood in stool Duration—Since age of seven Treatment—Operation for lymphangioma of knee Rectal examination not made Results—Post-operative rectal hæmorrhage Impossible to operate Death

CASE IX—Reported by Reichel and Staemmer, 1924, male, seventy-eight years of age Results—Seen at autopsy

CASE X—Reported by Buie and Swan, 1929, female Symptoms—Symptoms of gall-bladder disease Duration—Not stated Treatment—Gall-bladder operation Examination of appendix Results—Diffuse venous hæmangioma of appendix and cæcum

CASE XI—Reported by Buie and Swan, 1929, female, forty-eight years of age Symptoms—Passage of small amounts of blood Duration—Four months Acute obstruction one month Treatment—Operation for obstruction Results—Annular cavernous hæmangioma in colon

CASE XII—Reported by Hume, Graydon O, 1922, male, forty-eight years of age Symptoms—Repeated rectal hæmorrhages Duration—Since age of twelve Treatment—Transfusion and packing of rectum with kaolin paste Results—Death by hæmorrhage

CASE XIII—Reported by Bensaude and Antoine, 1923, female, twenty-one years of age Symptoms—Hæmorrhage of the rectum associated with pain, anæmia, severe cachexia Duration—Many years Treatment—Operation Diffuse angioma of rectum and sigmoid Artificial anus made in transverse colon Post-operative X-ray therapy Results—Improved (Still under treatment)

CASE XIV—Reported by Bensaude and Antoine Symptoms—Profuse hæmorrhages of rectum Duration—Not given Treatment—Operation Symptomatic and injections morphine Results—Death from hæmorrhage

*Treatment*—In the cases noted palliative measures, such as irrigations of styptic substances per rectum, rest, morphine, transfusions, *etc*, have been the medical therapy In one case a permanent anus was established and the bowel containing the angioma resected In another a permanent colostomy was made in the transverse colon, and the sigmoid treated by radium therapy

*Diagnosis*—In any patient who complains of persistent bleeding from the rectum over a period of years, usually beginning in infancy, angioma should



be suspected If the angioma occupies the rectosigmoid, the diagnosis may be readily made from the appearance as seen by proctoscopic examination Unless there should happen to be a pedunculated tumor X-ray is of little importance from a diagnostic point of view

**CASE REPORT**—B L, male, Russian Jew, born in the United States, aged seventeen First admission to Fifth Avenue Hospital March 12, 1930 *Chief complaint*—Bleeding from rectum Since fifteen months of age patient has complained of frequent attacks of bleeding from the rectum He has had no pain except when passing a constipated stool Has periods of diarrhœa and constipation, and stools always appear streaked with very dark blood At times when he has diarrhœa he passes bright red blood, which varies in amount from a quarter to a half glass at a time There are times when he uses mineral oil, when he has very little bleeding These times he may bleed only once out of about ten times

*Past History*—Diphtheria as a child At four years of age had an operation for hemorrhoids, and other rectal operation, of which he is not quite certain, at about six years of age Becomes short of breath on exertion, and has had fainting sensations and has fainted occasionally after any muscular exercise His best weight has been 142 pounds, at present he weighs 136 Has never been able to exercise on account of faintness

*Physical Examination*—Pale, slender youth Eyes react to light and accommodation Pupils are equal Mouth in good condition Tonsils absent Lungs clear throughout Heart Regular rhythm, fair quality Has a powerful beat with P M I within mid-clavicular line in fifth interspace No irregularity or murmurs Abdomen negative Some gas in intestines noted

*Digital Examination*—There is no enlargement of the prostate, or noticeable hemorrhoids There seem to be a few tabs of mucosa just within the sphincter

*Laboratory Examination*—*Urine*—Specific Gravity, 1020 Very faint trace of albumin Microscopic negative *Blood Count*—Hæmoglobin, 32 per cent, Red Blood Cells, 2,800,000, White Blood Cells, 6,500, Polynuclears, 77 per cent, Lymphocytes, 23, Achromia, Aniscytosis, Poikilocytosis *Blood Clotting Factors*—Prothrombin, 10, Fibrinogen, 0.64, Antithrombin, 10, Platelets, 370,000, Disintegration, 40 per cent, Index 0.6

*Proctoscopic Examination*, March 12, 1930—Sigmoidoscope admitted without meeting any obstruction for ten inches Examination reveals a red, beefy mucous membrane, with areas of blue cystic spaces beneath, and thin, smooth mucous membrane extending upward as far as can be seen through the sigmoidoscope and downward to the sphincter ani There are two small hemorrhoids just within the sphincter

*Diagnosis*—Congenital angioma of the rectum

A similar proctoscopic examination had been made two weeks before admission, and the patient referred to Dr Harvey Stone, in Baltimore, with a request for his opinion, without the author having stated his own diagnosis

Following is the report from Doctor Stone "The boy has two distinct lesions which may, or may not, be related to each other There is a fairly large and vascular internal hemorrhoid just to the left of the posterior commissure, and a smaller one further to the left of this In addition to that, the rectal mucous membrane from just above the valves to ten inches up (which was as far as I could see) presents a curious condition The veins are greatly dilated and engorged and tortuous They stand out like blood splotches against the pale mucous membrane I think this is a congenital angioma

*Comment*—A boy of seventeen years of age presented himself for treatment, having had repeated bleeding from his rectum since fifteen months of age He had a marked secondary anæmia and suffered from repeated bleed-

ing at stools. A diagnosis of angioma was made by proctoscopic examination and by the history. The problems which presented themselves when operation was contemplated were: (1) Would one be able to see, on the serosa side of the intestine, the distribution of the angioma? (2) If the growth were limited, obviously colostomy would relieve the situation temporarily, but should the fecal current be reestablished, bleeding would probably then recur. (3) A permanent colostomy, with or without resection of the entire distal sigmoid, was considerably of a handicap. For a boy of seventeen to feel that the rest of his days he would have to wear a colostomy cup or bandage did not present a pleasant future. (4) Having learned that certain port wine hæmangiomas had been cured by the injection of the veins with sclerosing substances, the author considered the use of this method in this particular case. Obviously, arterial injection might create gangrene of the bowel. If there were a free communication, as the pathology would suggest, between the superior hæmorrhoidal vein and the numerous venous sinuses, a sclerosing solution such as is used in the treatment of varicose veins of the extremities might readily eradicate the tumor. The possibility of gangrene of the bowel, following this injection with the necessity of a hurried second-stage abdomino-perineal excision of the rectosigmoid, was considered, but the seriousness of the boy's condition seemed to warrant this possible risk. At the time this operation was contemplated, the later sclerosing solutions such as invertose, quinine and urea, and sodium chloride, had not come widely into use. It was felt, with the possibility of only one injection, that a strong solution of sodium salicylate would be warranted. For this reason, 40 per cent sodium salicylate was the substance selected for the intravenous injection.

As the boy had two small hæmorrhoids, these were removed as a preliminary operation, in association with a couple of transfusions, in preparation for the major operation.

It was thought, in planning the operation, that a temporary colostomy would be necessary to put the bowel at rest, in addition to the intravenous injection of the sclerosing solution.

B. L. (First operation) April 10, 1930. (1)—Colostomy. (2)—Ligation of Superior Hæmorrhoidal Vein. (3)—Injection of Superior Hæmorrhoidal Vein with sclerosing solution (10 cubic centimetres of 40 per cent sodium salicylate). A right paramedian incision was made. On exposing the peritoneum the sigmoid and rectosigmoid were purple in color with distended tortuous vessels over the entire surface up to about 10 centimetres of the end of the descending colon. (See artist's sketch.)

The line of demarcation between normal and abnormal bowel was distributed over an area of about 2 inches, where vessels decreased in size until a normal appearance occurred. This occurred about 4 inches distal to junction of descending colon and sigmoid. Adhesions to lateral surface of sigmoid were freed so that it was possible to bring up the sigmoid for a colostomy. The mesosigmoid was perforated in the avascular zone and tape inserted through it. The portion of the bowel containing the angioma was then brought up into the wound and the mesosigmoid perforated on the mesial surface. It was seen that the part involved was apparently in the distribution of the superior hæmorrhoidal vein. The walls of the vein were extremely thin and there was an aneurysmal dilatation at the area exposed. The vein was dissected free from artery by sharp dissection and

ligature placed about it and tied. A needle attached to a hypodermic syringe was inserted into the lumen of vein distal to ligature and 10 cubic centimetres of 40 per cent sodium salicylate injected, very little spilling. It appeared to the operator and his assistant that shortly after this the purplish color of the intestines became lighter—almost pink. Ves-



FIG 1.—Artist's sketch made at operation. Exposure of superior hemorrhoidal vein through mesial sheath of meso sigmoid. Upper portion shows gradual transition of the tumor into normal bowel.

sels felt firm. The vein was again ligated below insertion of needle and the peritoneal cavity washed out with saline. The rent in the mesosigmoid was closed with chromic suture. A left McBurney incision was then made, incising skin and inserting Kelley clamp and spreading it so as not to split aponeurosis of oblique muscles any more than was necessary. Tape about the sigmoid was drawn up through this incision and the

bowel brought up through the skin incision. On the peritoneal side the bowel was united to the peritoneum with interrupted chromic sutures and lateral surface of the descending colon sutured to the lateral surface of the peritoneum to prevent bowel from herniating in this zone. Vaseline gauze tape was placed through the mesentery in place of tape that had been there previously. The bowel was sutured on the outside of the aponeurosis of the external oblique with interrupted fine chromic. Vaseline gauze inserted around colostomy. Median abdominal wound closed in the routine manner.

Colostomy opened by cautery at end of forty-eight hours. Rectal tube inserted and held by purse-string sutures.

Four days later colostomy revised with endotherm knife.

*Post-operative course*—Patient ran a smooth post-operative course, the colostomy worked satisfactorily, and he left the hospital at the end of three weeks.

Eight weeks after operation he was proctoscoped. At that time the dilated venous pools had completely disappeared. There were one or two areas of necrosis of the mucous membrane, with some sloughing. There had been no bleeding from the rectum since his operation. He was instructed to irrigate the distal segment of his colostomy with warm cotton-seed oil twice a week.

Seven months post-operatively the patient had gained 20 pounds and, for the first time in his life, had been able to enter into active sports, he had no difficulty in the use of his colostomy, and he had had no bleeding from the rectum.

As he was anxious to make up his classes in which he had become deficient due to his prolonged invalidism, we postponed the return to the hospital for closure of his colostomy until eleven months following the initial operation.

Three weeks before his re-admission, March 10, 1931, he was again proctoscoped. At this time the mucous membrane appeared somewhat atrophied. There were whitish scar-appearing specks where previously there had been dilated submucous venous spaces. It was explained to his parents that it would be necessary to explore him through his old median incision before deciding whether or not his colostomy could be closed. It was felt that the inspection of the colon where previously there had been tremendously dilated veins appearing on the subserosal surface of the sigmoid would indicate whether or not the sclerosing solution had obliterated them sufficiently to attempt a reestablishment of the faecal current. It was also explained to the boy's parents that a cæcostomy would be necessary in order to allow satisfactory closure of his colostomy after this long period of disuse.

(Second Operation) March 30, 1931. (1)—Exploratory laparotomy. (2)—Closure of colostomy. (3)—Cæcostomy. (4)—Appendectomy for chronic appendicitis. Ethylene anaesthesia. (1) Elliptical median incision excising the old scar, after having excluded the cæcostomy from the operative field by a gauze pack and placing over it a folded towel. The sigmoid was sought for and brought up into the wound. The appearance was entirely different than at the previous operation. The sigmoid had atrophied from disuse and the appearance of the vessels on its surface had changed noticeably. While there were still a few dilated veins the greater number appeared thrombosed and it seemed as if the vessels on the surface had diminished greatly in number. While the appearance of the serosa had previously been a deep purple it now had the normal pink appearance of intestines. It appeared to the majority of those present in the operating room as if it were safe to reestablish the faecal current. Therefore sterile string pads were placed over the median incision, the towels were refixed and (2) an elliptical incision was made about the former colostomy after excising the skin and skin was sutured over the colostomy opening to prevent soiling. By sharp dissection the intestine was freed from the layers of the left McBurney incision. When the sigmoid was freed the scar tissue was excised from the edges of the colostomy and the opening was closed in a transverse manner with an interior Pagenstecher inverting a suture reinforced with a continuous chromic mattress stitch. The sigmoid was then replaced in the abdominal cavity and the median incision was again exposed.



FIG 2—Artist's sketch taken at operation. Injection of the superior hemorrhoidal vein with sclerosing solution.

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(3 and 4) The cæcum was then sought for and an elongated appendix found with adhesions in the middle third, binding it laterally, and sharply kinked. The appendix was removed with a double inversion of the stump. About 8 centimetres distal to the ileocæcal junction a purse string suture was inserted. A stab wound was made and a large rectal tube inserted and passed up to the ascending colon. The tube was held in place by three reinforcing additional purse-string sutures. A small right McBurney incision was made and the distal end of the tube drawn out through this incision and the cæcum sutured to the peritoneum at its exit. The median and the left intermuscular incision were then closed.

*Post-operative Course*—On the twelfth post-operative day the patient developed a fæcal fistula in the median incision, which created a small breaking down of the incision for a distance of about 3 centimetres. The cæcostomy tube had been removed on the eighth post-operative day. The patient was discharged from the hospital on his twenty-sixth post-operative day, at which time all three wounds were healed with the exception of a very slight seepage through the median wound, which was not fæcal in character. The patient had no bleeding from his rectum and his bowels moved regularly each day with the aid of mineral oil. His general condition was satisfactory.

A follow-up report from the patient on July 1, three months after his operation, stated that the boy was away at camp, was feeling perfectly well, and his bowels moved daily with the aid of a small amount of mineral oil. Twice in the first fortnight after he returned home, when his bowels were very constipated, he had a slight amount of blood-tinged mucus coating a hard stool. Since then he has noticed no blood whatsoever, is able to exercise, and to act as other youths of his own age.

As fifteen months have elapsed since the injection of the sclerosing solution into the superior hæmorrhoidal vein and no bleeding has occurred during that time, the assumption that the patient is cured appears warranted.

*Conclusions*—(1) Hæmangioma of the rectosigmoid is usually congenital in origin. (2) The most prominent symptom is repeated bleeding from the rectum, usually beginning in the first decade of life. (3) The condition is serious, as death from hæmorrhage is apt to occur. The treatment of the cases reported has been, in general, unsatisfactory. (4) A case is reported wherein a cure was accomplished by the injection of the superior hæmorrhoidal vein with a sclerosing solution. Colostomy and later closure of the colostomy was performed in order to put the bowel at rest during the period of repair.

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# SOME ANGIOSPASTIC SYNDROMES IN THE EXTREMITIES

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THE increased interest in the peripheral vascular diseases has focused attention especially on the lesions associated with spasm of the vessels. This is a natural reaction because it is in this group that therapeutic relief can be looked for more hopefully in a large proportion. The group dependent mainly on occlusion of the vessels offers much less opportunity for striking improvement although palliation and slowing of the natural progress of the disease may be brought about.

In previous communications,<sup>1, 2, 3 4, 5 6</sup> we have recorded some of our experiences with the more common types of peripheral vascular diseases. But since our interest has been attracted to this subject we have recognized a variety of angiospasm, not dependent on organic vascular disease, which have been difficult to classify under any of the accepted nomenclatures. Indeed, it has been almost impossible at times to be certain even about Raynaud's disease according to the criteria given in the literature for a diagnosis of this condition. We have adopted a tentative classification of our own under which we have placed individual cases of angiospasm in the extremities as they seemed most closely to fit the picture. Thus, in addition to the spastic element in the organic vascular diseases, we have first, idiopathic paroxysmal acral ischæmia generally spoken of as Raynaud's disease, secondly, arteriospasm dependent on organic or functional nervous disorders, thirdly, that consecutive to trauma, and lastly, true venous spasm.

*Vasoconstrictor Gradient in the Hands*—In former reports we called attention to the normally acting vasoconstrictor gradient which is most marked in the lower extremities after exposure to the air. This gradient also does occur in the hands but it is much less prominent under ordinary conditions. It can be brought out in the hands by fulfilling appropriate conditions as we have already recorded. There is a group of people who normally have an accentuation of vasoconstriction in the hands. They seldom consult a physician as their complaint is regarded by them as trivial, not requiring medical attention. Their only inconvenience is coldness of the hands which may be quite striking in contrast to the warmer portions of the skin surface. The following case history furnishes a well-marked example of this exaggerated vasoconstrictor gradient in the hands.

CASE I—A S, Strong Memorial Hospital, No. 38082, a twenty-five-year-old housewife, came into the hospital on account of abdominal pain, due to a chronic salpingitis. In the past history given to the clinical clerk, she said that her hands had always had a marked tendency to be cold. If either hand touched any other part of her body, she felt this difference in temperature. She had never noted any attacks of unusual pallor or cyanosis.



in the hands, however. On palpation the hands felt cold and on measurement of the surface temperatures a very sharp vasoconstrictor gradient in the hands was evident. The palmar surface of the fingers registered a temperature of  $22^{\circ}$  when the room temperature was  $19.4^{\circ}$  C. The surface temperature at the wrist was  $28.5^{\circ}$  C and in the lower arm was  $29.5^{\circ}$  C. This patient had never had any symptoms aside from coldness of her hands which she herself had noted.

This is a much greater degree of vasoconstriction than most individuals will show in the fingers under ordinary conditions with a room temperature of  $19-20^{\circ}$  C. It is difficult to get evidence of spasmodic attacks in these people, many of whom give a story of cold hands and cold feet most of the time. It may be that this is a mild type of reaction which in its more severe forms presents the angiospastic attacks which we call Raynaud's disease. But it seems hardly legitimate to classify this as Raynaud's disease although the difference may be only in degree.

*Idiopathic Paroxysmal Arteriospasm (Raynaud's disease)* — There have been a number of patients with paroxysmal arterial spasms not due to some other disease or injury. Such attacks usually come on in cold weather, but sometimes also during the warmer parts of the year. These patients are completely relieved between attacks at which time upon examination they seem to have normal blood-vessels. The areas involved usually are symmetrical ones on the hands, the feet, or both. The degree of involvement ranges from a mild one with transient dead fingers or toes to a severe one in which attacks of ischæmia are frequent and prolonged, ultimately ending in gangrene of one or more digits. It is possible to bring on typical attacks by exposure of the extremities to a proper degree of coldness, or by allowing rapid evaporation of moisture from the exposed extremities. The attacks are often accentuated by reflex painful, or psychic stimuli, or may be started by such stimuli when the environmental conditions are suitable. The following three case histories bring out certain points which we wish to emphasize.

CASE II — E. D. J., Strong Memorial Hospital, No. 45225, a forty-six-year-old housewife, had been having attacks in which several fingers became white, cold and numb during the past eighteen months. The fingers involved remained cadaveric or deeply cyanotic for one-half hour or more at a time and then the circulation gradually returned to these areas accompanied by a tingling sensation. There was no pain during the attacks but the involved fingers were hypersensitive immediately afterwards, on two occasions there has been aching in the arm. Also the attacks were much more apt to occur in cold weather or when she got her hands in cold water, though the low temperature was by no means the only factor in initiating them. The patient had noted herself that the attacks were more numerous when she was nervous, and they frequently occurred upon awaking in the morning. There had been no trophic changes but she was not able to carry out as well-skilled movements with the fingers such as in the use of a needle unless she had warmed her hands in warm water first. Her feet suffered similar changes but the attacks here were less noticeable to her.

Pulsation in all major vessels in the extremities was good even during the attacks. A number of attacks were seen in the clinic involving especially the right index and middle fingers and the thumb. Such attacks were induced by immersion of the hands in cold water of the proper temperature. However, they were not uniformly reproduced.

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by the same physical conditions, for immersion in water at  $15^{\circ}\text{C}$  for five minutes one time brought out a sharp attack involving the right index and middle fingers, but on another occasion it failed to do so. Psychic stimuli, such as an unexpected movement of the patient to an examining room, discussion of an operation for an independent condition which the patient had, namely, an epithelioma, *etc*, produced typical attacks of pallor in certain fingers. However, the attacks induced in this manner at ordinary room temperatures did not usually last as long as those artificially brought on by cold. Recovery from all of the attacks took place spontaneously at a room temperature of

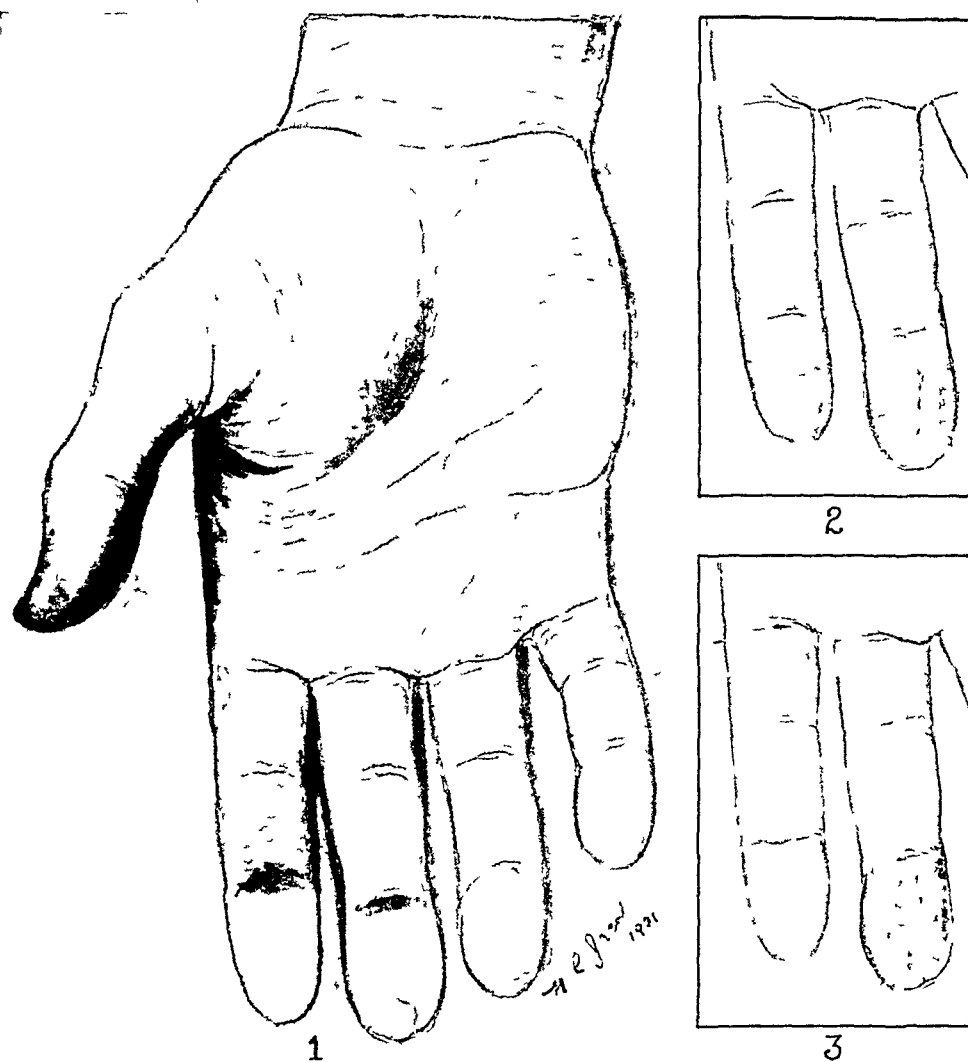


FIG 1—Case II Raynaud's disease, spontaneous recovery (1) Shows the appearance of the right hand after ten minutes in a water bath at  $15^{\circ}\text{C}$  (2) The white area of the middle finger has become deeply cyanotic and a bar of color has come across the ischemic area in the index finger. This bar gradually became brighter in color and spread through out the terminal phalanx so that (3) fifteen minutes after coming out of the bath the index finger was hyperæmic while the middle finger was still intensely cyanotic.

$18-20^{\circ}\text{C}$  generally within one-half to one hour. The feet were usually rather cyanotic on exposure for twenty minutes at  $20^{\circ}\text{C}$ . The toes showed pallor and fairly intense cyanosis at times, but the condition was not nearly as striking as in the fingers. Spontaneous recovery from an attack in one finger, the distal half of which was dead white, occurred in a somewhat patchy manner, a bar of color coming across the center of the terminal digit while both proximal and distal to that point the finger was still absolutely

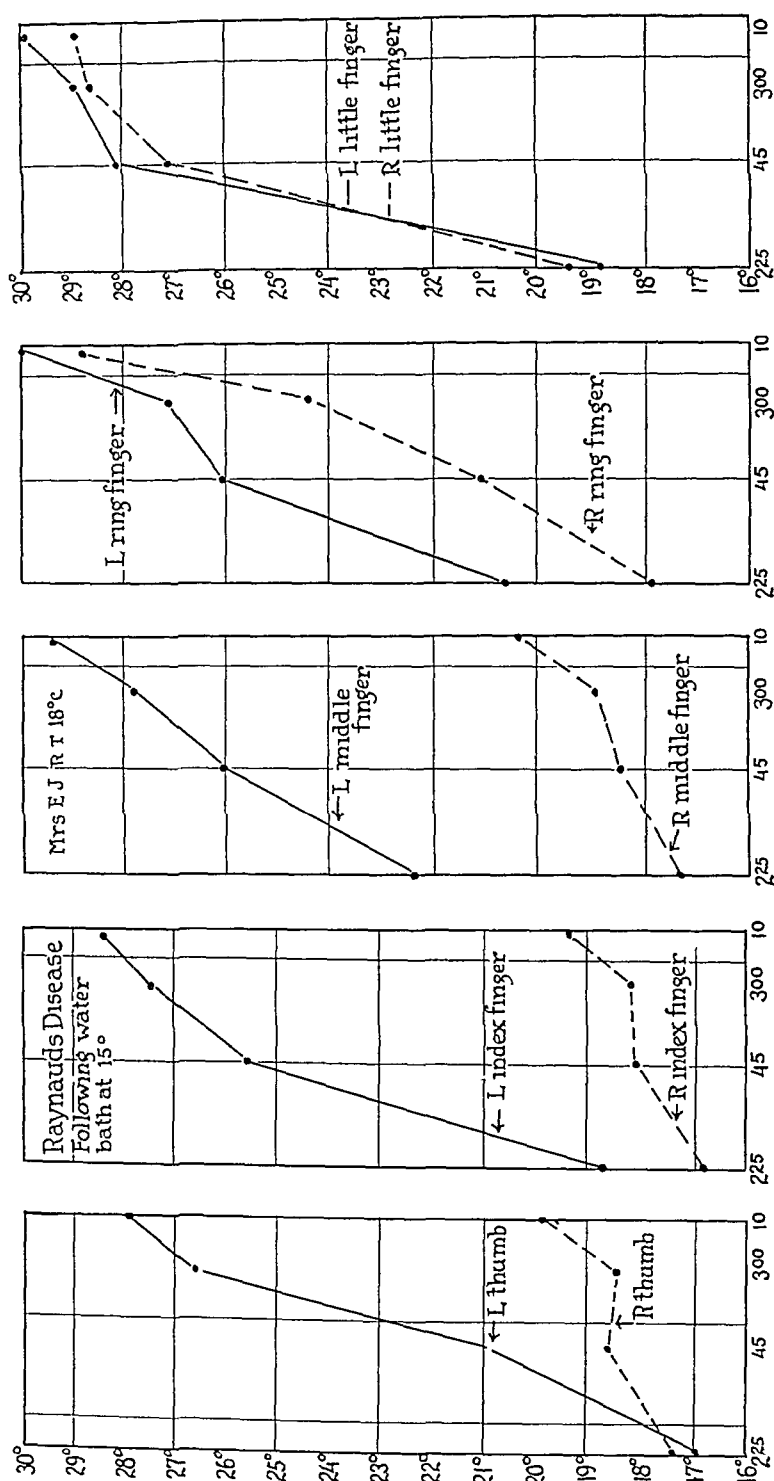


FIG. 2.—Case II. Raynaud's disease. Surface temperature of the fingers after immersion for ten minutes in water bath at 15° C. Note that the right thumb, index and middle fingers, which were the ones chiefly involved in this case, recovered their temperatures very much more slowly than the corresponding ones on the left hand and the ring and little fingers on both hands.

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ischæmic (Figs 1 and 2) Ten minutes later this finger had not only recovered but was hyperæmic while the middle finger was still intensely cyanotic. An observation of some significance in regard to the influence of nervous stimuli in this condition was the following. The patient had been in the constant temperature room for about two hours. A typical attack of spasm in two of the fingers of the right hand had been induced by immersion in cold water in the early part of this time. The patient had fully recovered from this, both the color of the fingers and their surface temperatures had not changed significantly for an hour. A perineural infiltration was made about the left posterior tibial nerve and the point of the needle touched the nerve trunk causing an instantaneous painful sensation. This produced a sharp attack of ischæmia on the pad of the right thumb (Fig 3) together with an increase in the rather slight degree of cyanosis already present in the index and middle fingers of this hand. This spastic reaction in the hand lasted for about five minutes. Nerve block of the left posterior tibial nerve caused a temperature rise to the normal vasodilatation level in the anæsthetic area.



FIG 3—Case II Raynaud's disease. Effect of reflex painful stimulation. (A) Normal appearance of thumb before injection. (B) Ischæmic area on pad of the right thumb which was induced by painful stimulation of the left posterior tibial nerve.

This patient would be regarded as a mild form of Raynaud's disease by some. The beginning of attacks at such a late period in life would be regarded by others as against this diagnosis and they would name it intermittent "dead fingers." It is certain, however, that the conditions necessary for bringing on an attack by exposure to cold had to be strictly followed in her case. An assistant was instructed to put the patient's hands in a water bath at  $15^{\circ}\text{C}$  but being anxious to help, made the temperature  $10^{\circ}\text{C}$  instead. This failed signally to bring on a spasm, the fingers reacting fully with hyperæmia and increased surface temperatures after being withdrawn from the bath, much the same as in normal individuals. Typical attacks could be induced at  $15^{\circ}\text{C}$  but not uniformly as occasionally such an experiment would fail. Subjectively, she had noted that her attacks were more

frequent when she was nervous. Objectively, we were able to bring on clear-cut mild attacks of ischaemia by psychic, painful or reflex stimuli as described in the history.

CASE III—C. H. D., Strong Memorial Hospital, No. 46368, a salesman, aged fifty-eight, came to the hospital on April 20, 1931, having had a variety of treatments for Raynaud's disease during the past nine years. The onset of symptoms was abrupt, noted first in the toes but soon appearing in the fingers. The attacks consisted of sudden painless pallor of the digits, followed by prickling, numbness, and aching, and by an intense cyanosis. Moderate cold (as cool tap water) would bring on an attack. Spontaneous recovery occurred after a varying interval of one-half to two hours. The attacks were much more frequent in cold weather but he was not entirely free from them during the summer. The involvement was symmetrical, and soon after the onset of the trouble the fingers became more severely affected than the toes. Five years ago he had had a small spot of dry gangrene on the tip of the right ring finger lasting three months. Three years ago, there was a recurrence of ulceration at this point which did not entirely heal for two years. During the past winter the attacks had become more severe and in the feet the area of pallor and intense cyanosis had extended back over the metatarsals instead of being limited to the phalanges.

A significant point in the history was that the attacks were very often brought on by some unexpected event. Thus if he had been sitting quietly reading for an hour or more in a room of moderate temperature and the telephone suddenly rang, an attack would frequently be initiated. His fingers would become cyanotic before he could reach the telephone. This important effect of psychic stimuli in bringing on attacks was clearly demonstrated several times while the patient was in the hospital. Thus, the first trip to the constant temperature room (no cooler than the temperature of the room from which he had come), the introduction of a hypodermic needle, or even the description of a perineural injection that was to be carried out initiated sharp arteriospastic attacks. On the morning that the patient was to be shown to the students on rounds, his hands were exposed on the porch for an hour in order to bring out the typical appearance. In spite of the fact that it was a cool morning when we came to see him after this period of exposure the hands showed only a slight cyanotic tint, in fact as a demonstration of an attack of Raynaud's disease their appearance was at this point a complete failure. As soon as the group assembled about his bed the color of the hands immediately began to change and they became profoundly cyanotic within three minutes. The different attacks observed during his stay in the hospital varied in severity and duration. In them the whole hand became cyanotic but the fingers were most intensely so, the distal two-thirds being a bluish black in the more severe attacks. In a typical one of the latter, the right ulnar nerve was blocked with novocaine, anaesthesia being complete within ten minutes. By the time sensation in the ulnar areas was lost, blotches of red had appeared in the anaesthetic area of the palm and at the base of the little finger. During the next fifteen minutes these spread to include the whole of the ulnar area in the palm, the proximal and part of the middle phalanx of the little finger, and areas on the ulnar side of the proximal phalanx of the ring finger (Fig. 4). The rest of the hand as well as the other hand remained cyanotic. The terminal phalanx of the little finger became lighter in tint but did not lose its cyanosis. The temperature on this finger rose a maximum of  $2^{\circ}\text{C}$  as compared with an increase of  $5^{\circ}\text{C}$  in the anaesthetized area of the palm. The color of the distal half of the ring finger did not change from its profound cyanosis and no difference in the tint of its ulnar and radial sides was discernible although the former was anaesthetic and the latter was not. There was no increase in the surface temperature of the distal phalanx of this finger. The next day the right posterior tibial nerve was anaesthetized by perineural infiltration just below the internal malleolus. The cyanosis in the hands which was only moderate before the injection was intensified for several minutes immediately after this procedure. The patient had been under observation in the constant temperature

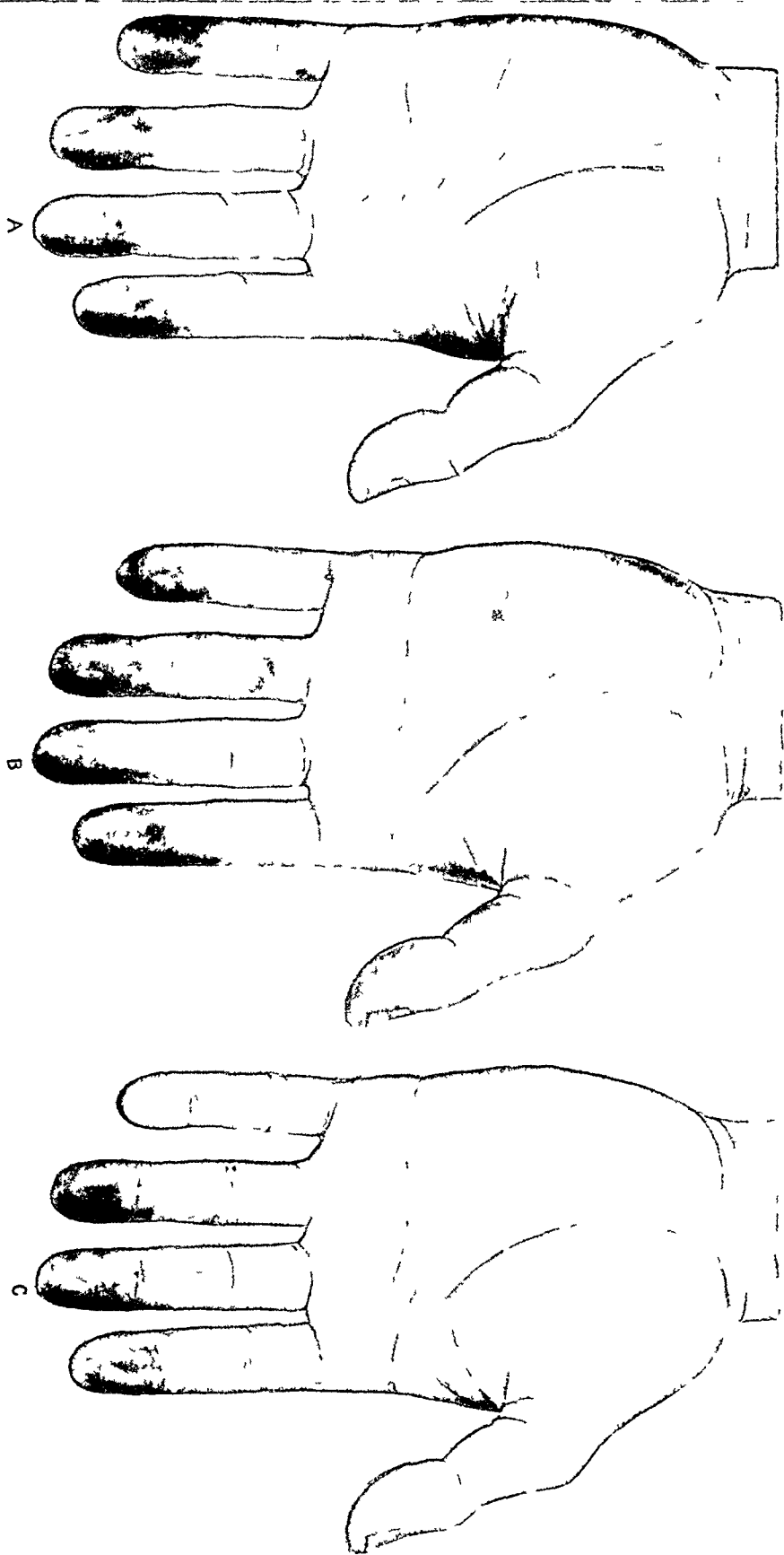


Fig 4—Case III Raynaud's disease Block of ulnar nerve. (A) Appearance of the hand before blocking the nerve. The whole hand is cyanotic, the extremity of each finger is extremely so. (B) Ten minutes after the nerve block, areas of bright red coloration have appeared in the ulnar region of the palm in the proximal phalanx of the little finger and on the ulnar side of the proximal phalanx of the middle finger. (C) One half hour after ulnar nerve block, the red areas have spread to include practically the whole of the anesthetic area on the palm most of the little finger and the ulnar side of the proximal phalanx of the ring finger. This was the maximum improvement obtained. Note particularly, however, that the distal half of the ring finger is unchanged and that the cyanosis in the distal phalanx of the little finger has not cleared up. There was complete anesthesia of the whole little finger and the ulnar half of the ring finger.

room for an hour previously and the soles of the feet were cold and markedly cyanotic. Anæsthesia was evident on the plantar surfaces of the foot and toes in twelve minutes. About five minutes later redness appeared on the heel and sole of the foot and slowly progressed over the metatarsal heads and onto the toes. The tips of the first, second and third toes remained blue for twenty minutes after anæsthesia was established, but the cyanosis here finally disappeared and the whole anæsthetic area became a bright pink in sharp contrast to the violet color which persisted unchanged on the sole of the other foot (Fig 5). The temperature in the anesthetized toes rose more slowly than normally but increased  $9^{\circ}\text{C}$  and came to within one degree of the normal vasodilatation level.

This case likewise would be questioned as Raynaud's disease by some physicians because of his age and sex. There was nothing to make one



FIG 5—Case III. Raynaud's disease. Effect of blocking the right posterior tibial nerve. (A) Before injection. (B) Half an hour after injection cyanosis has been displaced by hyperæmia everywhere except the second and third toes and the tip of the first toe. (C) Ten minutes later the cyanosis has disappeared from these residual areas. The cyanosis in the left foot (like that of A) remained unchanged throughout.

suspect thrombo-angitis and in every regard the ischaemic attacks were characteristic. Here, again, the patient volunteered information that any unexpected event was likely to start an attack in his hands, and we were able objectively to cause obvious arterial spasm in the hands by psychic and by painful stimuli.

CASE IV—F C B, Strong Memorial Hospital, No 38360, a thirty-two-year-old clerk, came to the clinic in September, 1930. Since the age of twelve he has had attacks of extreme cyanosis in the hands and feet, brought on principally by exposure to cold. Ten years ago the second toe of the left foot became sore and ulcerated and for four years it was impossible to heal this lesion. Six years ago a left periarterial sympathectomy

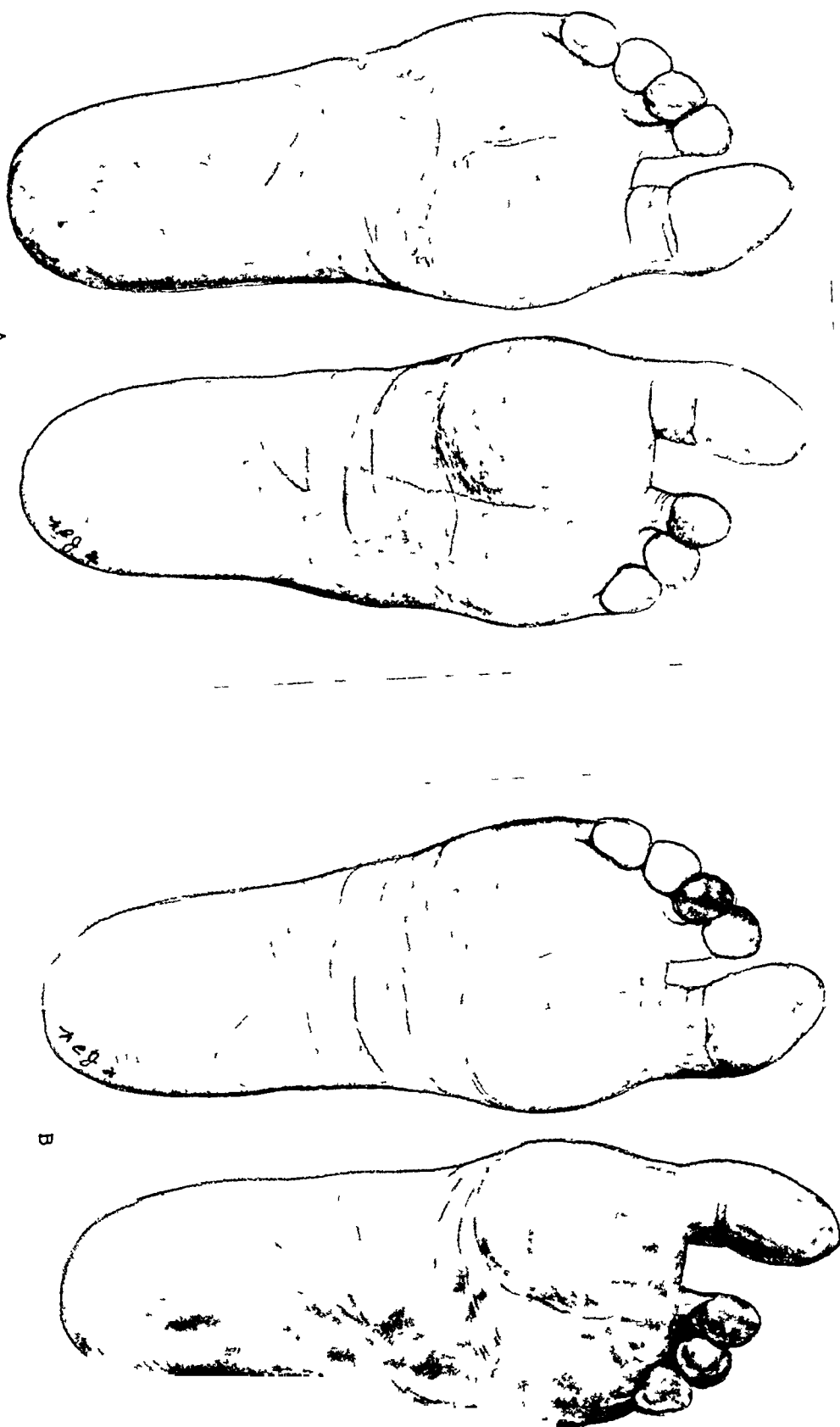


Fig 6—Case IV Raynaud's disease Effect of blocking the left posterior tibial nerve (A) Appearance of the feet in an attack before nerve injection (B) Forty minutes after the nerve injection, the whole of the left sole and toes has become a bright pink The right foot had remained cyanotic with the exception of areas of spontaneous recovery on the first and fourth toes



was done and when this did not improve the condition of the toe, the latter was amputated. The wound healed without complication. The lateral side of the left foot had ulcerated on several occasions but had always healed slowly. The hands also were subject to attacks of cyanosis but had not shown any trophic disturbance. The patient had to protect his hands and feet in cold weather. Following a very severe attack he had some pain.

The patient was obese, with scanty hair and a feminine habitus. His appearance suggested hypopituitarism though the X-ray of the sella was normal. We have seen the patient in several attacks during which the feet became extremely cyanotic and the hands markedly so. During the attack good pulsations in the major vessels of the extremities were palpable. An attack was brought on by exposure in a cold room. After the fingers had become deeply cyanotic and the soles of the feet an intense blue, the left posterior



FIG. 7.—Case IV. Raynaud's disease. Effect of blocking the left posterior tibial nerve. This figure illustrates the stages in the recovery of the left foot shown in Fig. 6. (A) Ten minutes after injection of nerve. Areas of red appearing in the sole of the foot and the great toe. (B) About twenty minutes after nerve injection cyanosis had disappeared completely from the whole sole of the foot and toes except the end of the third toe. This still was deeply cyanotic. (C) Thirty minutes after nerve injection the cyanosis on the third toe had also completely disappeared.

tibial nerve was blocked by the injection of novocaine about it. In five minutes areas of bright red sharply contrasting with the deeply cyanotic background appeared on the sole of the foot and soon afterwards also in the middle of the plantar surface of the great toe. These islands of red color spread gradually until the whole plantar surface of the foot except the third toe was a bright red. About twenty minutes after the induction of the anesthesia, this digit also slowly became as bright red as the rest of the foot (Figs 6 and 7). The sole and heel of the right foot (uninjected) remained cyanotic throughout to the end of the two-hour observation period. Spontaneous recovery had occurred in a few areas on the toes, particularly the fourth toe which had become a fairly bright pink. The surface temperatures in the anesthetic area came up to the normal vasodilatation level while the temperature of the toes on the unanesthetized side remained between  $21.5^{\circ}\text{C}$  and  $23^{\circ}\text{C}$ , room temperature being  $20^{\circ}\text{C}$  (Fig. 8). This vasomotor

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test showed how completely the removal of the vasoconstrictor impulses relieved the vascular spasm in this patient's foot, even in the area on the third toe where this persisted much longer after anaesthesia was induced than in the other regions

From our observations in Raynaud's disease we have been able to confirm in the main, the conclusions of Lewis, Kerr and Landis<sup>7, 8, 9</sup> The attacks can usually be produced experimentally by exposing the extremities to a temperature of 15° C. When allowed to recover spontaneously from such an attack, the return of color is in a patchy distribution, small areas appearing as islands of redness in the cyanotic zone and gradually coalescing to form larger patches. There is no sudden let-up with a flush similar to that following the release of a tourniquet, but the spread is in general from the base slowly to the periphery of the digits as if by a seepage through

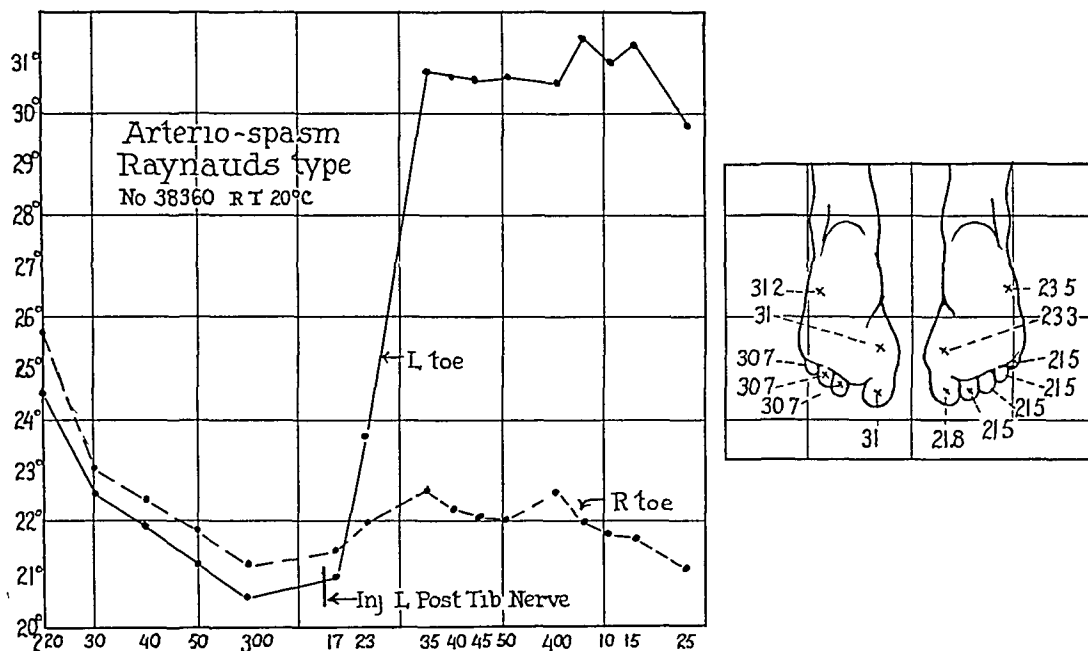


FIG 8—Case IV Raynaud's disease Effect on the surface temperatures of the great toes of blocking the left posterior tibial nerve On the anesthetized side the normal vasodilatation level is reached

small leaks. The recovery of color is in the reverse order to its appearance when the attack is produced. The surface-temperature readings in the involved digits indicate a slower return to the normal than in the uninvolved ones, but except in the severe cases the recovery is complete. In the latter there may be a failure to reach the normal vasodilatation level. We do not regard a three-phase color reaction as necessary in order to make a diagnosis of Raynaud's disease. The color of the skin is dependent on the state of the circulation through the subpapillary network, and the amount and degree of oxygenation of the blood in this network. If there is very little blood, there will be pallor or a yellowish tint, if the circulation is rapid, a red color, if stagnant with blood trapped in this zone, it will lose its oxygen and the cyanotic phase will result. When an attack is present, conduction nerve block will cause complete anaesthesia in the cutaneous area supplied by that

nerve Recovery of color from the pallid or cyanotic to the pink phase takes place in the same patchy, slowly advancing way as it does when there is spontaneous recovery from an attack The surface temperatures may slowly mount to the normal vasodilatation level, or the level may not be reached in certain severe cases

It seems certain from these studies that the essential abnormality in Raynaud's disease is a local hypersensitiveness of the peripheral smaller arteries to cold as Lewis has emphasized There is no sudden release of spasm as one would expect on paralyzing the central vasoconstrictor mechanism by conduction block anæsthesia It may be significant, however, that spasms provoked by cold usually occur only in the areas which normally exhibit a vasoconstrictor gradient From our observation we are inclined to stress the importance of the vasoconstrictor influence in this condition more than Lewis has in his writings The voluntary subjective histories of initiation or accentuation of attacks by nervous factors in these patients has been substantiated by objective tests in our hands in a sufficient number of instances to make us believe that the vasoconstrictor mechanism also has an important rôle, though perhaps usually a secondary one Thus our opinion is that Raynaud's disease is not primarily due to an abnormality in sympathetic innervation, yet that the majority of the attacks except in the most severe cases are initiated or accentuated by vasoconstrictor stimuli under the ordinary living conditions of these patients We have not seen a case of Raynaud's disease where regional anæsthesia failed to cause some improvement in the circulation to the ischæmic extremity, though in the more severe cases, the most distal part of the extremity might remain uninfluenced by it The more or less extensive relief afforded by surgical removal of vasoconstrictor influences also tends to bear out this opinion We feel, therefore, that there is a proper justification for radical surgical attack on the sympathetic system in severe cases provided that it can be shown by appropriate tests that the surface temperature in the involved digits can be brought nearly to the normal vasodilatation level (This is also in agreement with Lewis's opinion though he does not give it much prominence) On the other hand, it is futile to operate on every case of Raynaud's disease with the expectation of a complete cure When the hypersensitiveness to cold is so pronounced that release of vasoconstriction by appropriate tests fails at ordinary room temperatures to raise significantly the surface temperatures in the digits, a poor result must be inevitable from any operative procedure We believe, then, that in typical Raynaud's disease there is a dual control operating to cause spasm of the peripheral vessels The essential defect is a hypersensitiveness of the peripheral vessels to cold But the vasoconstrictor influences are powerful in bringing on and keeping up attacks and their removal may be effective in prevention

*Angiospasm in Functional and Organic Nervous Disorders*—The functional and organic nervous system disorders may at various times exhibit derangements of the vasomotor mechanism to the extremities We have

selected a few instances to illustrate the increased vasoconstrictor response of this type. It is interesting to note that these patients also show an intensification of their pain and vasoconstriction on exposure to cold. This fact would hardly seem to be dependent on a constitutional local hypersensitivity of the peripheral vessels to cold and serves to emphasize the involvement of the sympathetic nervous system in many such conditions. It is only necessary to recall the cold, clammy extremities in patients with long-standing paralyses of anterior poliomyelitis, or the changes in surface temperatures in the later stages of the hemiplegic extremities, as also in some cases of spina bifida<sup>1</sup> to realize the broad field of this vasoconstrictor activity which should be explored further.

CASE V—A. V. S., Strong Memorial Hospital, No. 43979, came into the clinic in February, 1931, on account of pain in the right knee and coldness of the right foot. Three years ago the patient struck her right knee going up a flight of stairs. This was not a particularly severe trauma. Beginning a few weeks after this, she noted pain in this knee and for the last two years has had weakness of the right leg, particularly on walking. There has been an associated coldness of the right foot which the patient has noted repeatedly. On examination she had definite atrophy of the right soleus and gastrocnemius, a bilateral positive Babinski's sign, gross fibrillary twitchings in both quadriceps muscles. After the patient's feet had been exposed in a moderately cold room, the right foot was obviously cooler on palpation than the left. Measurement showed that when the patient was in a fairly warm room little difference was evident in the two feet. But on exposure in a cool room ( $18^{\circ}\text{C}$ ), a difference of  $2^{\circ}\text{C}$  between the temperatures of the two feet would be brought out. This was noted on several occasions, the right always being the colder.

The patient apparently had an organic nervous disease of the type of amyotrophic lateral sclerosis with more marked manifestations in the right leg. Accompanying this condition there was an increased vasoconstrictor activity which under certain circumstances was latent but which could be brought out under the proper conditions, especially in a cool room.

CASE VI—F. D., a vigorous laborer, sustained a fracture of both bones of the left lower leg two years previously. After the cast was removed it was found that the patient had anæsthesia in the foot, together with loss of motor control of its movements. He was referred for consultation because of the fact that associated with these symptoms he had an easily palpable difference in the temperatures of the two feet, the anæsthetic one being constantly cooler. The fracture has been completely healed for one and a half years. In spite of the patient's inability to flex and extend the toes or the foot at the ankle on the left side, he had no significant atrophy and no toe drop on walking. There was complete anæsthesia of the foot and irregular regions of anæsthesia and hypoaesthesia extending as high as Poupart's ligament, the distribution of which had no definite pattern of either peripheral nerve or nerve-root involvement. It was obvious that this was a functional nervous disorder to be classed as a post-traumatic hysteria.

It is of interest that although the area of distribution of this nerve was completely anæsthetic, when the posterior tibial nerve was touched with a needle just below the internal malleolus, the patient experienced a sharp pain. Apparently the unexpected stimulation of the nerve in this manner produced the normal response to pain. The latter was inhibited in his condition upon the peripheral stimulation in the manner with which the patient was familiar.

The interesting feature in regard to this patient was that the surface temperatures in the left toes were constantly two degrees cooler than in the right. After blocking the left posterior tibial nerve, however, the temperature of the left foot came up to the normal vasodilatation level and there was no evidence suggesting organic disease of the blood-vessels (Fig 9). Evidently then, in this case of post-traumatic hysteria, there was an increased vasoconstrictor tonus in the involved foot. It would be of interest to know whether hysterical manifestations in an extremity are regularly accompanied by a similar increased vasoconstrictor activity or whether this was a fortuitous feature in this instance.

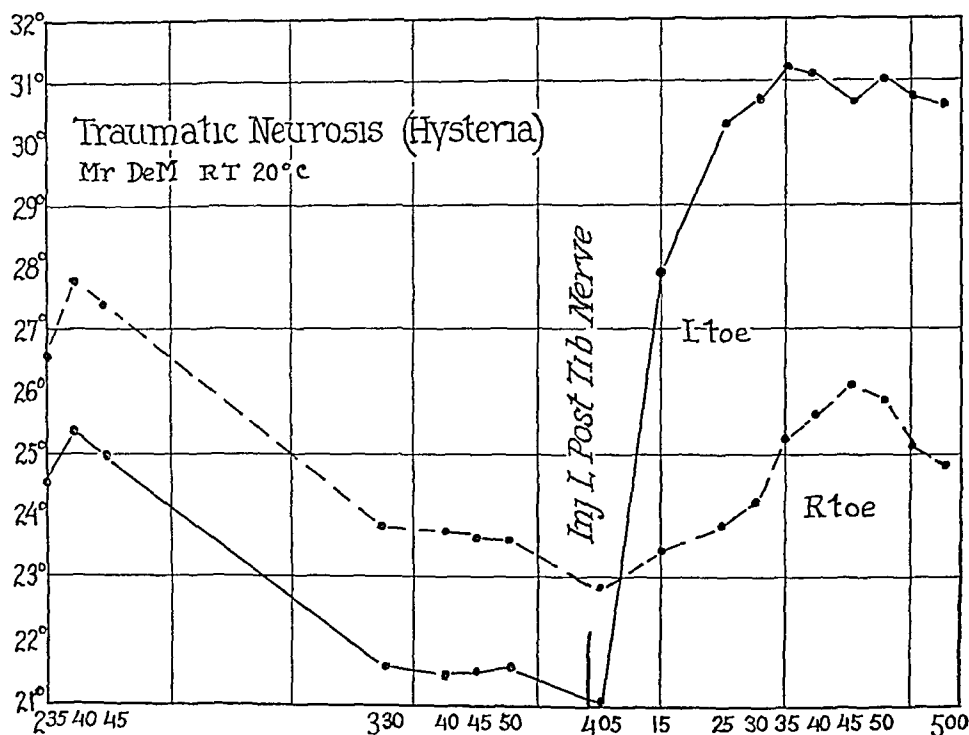


FIG 9—Case I I Traumatic hysteria. Surface temperatures on the toe of the affected side remained 2° C below that of the uninvolved side. After blocking the left posterior tibial nerve the temperature rises sharply above that of the normal foot and reaches the normal vasodilatation level.

CASE VII—M S, Strong Memorial Hospital, No 8919, a sixty-three-year-old housewife, with moderate general arteriosclerosis and occasional symptoms of cerebral arteriosclerosis, had a Colles fracture of the left wrist in April, 1930. Following this she had numbness and pain in the left thumb, the index and middle fingers. The pain increased and became burning in character. The application of cold to the peripheral area produced very intense pain, so that at home she constantly wore a woolen sock over this hand. This effect of cold was verified in the clinic by putting the patient's hand in water at 13° C for ten minutes which produced an intense pain and from which the involved fingers recovered their temperatures more slowly than the corresponding areas of the opposite hand. This was a typical causalgia of so severe a degree that alcohol injection was resorted to. The median nerve was blocked just above the wrist, it was found that this nerve had become adherent to the callus at the site of the fracture in the ulna. Anaesthesia has persisted and the patient has remained free of pain for six months since.

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this procedure The anæsthetic areas on the fingers have remained colder than the corresponding areas of the opposite hand

This patient illustrates very nicely the hypersensitivity to cold induced by local involvement of a peripheral nerve This hypersensitivity showed itself by the pain and by the increased vasoconstriction, both being elicited by cold applied to the area of distribution of the involved nerve

*Angiospasm Consecutive to Trauma*—The fact that trauma was also noted in the histories in Cases VI and VII leads us to the consideration of the next group of patients who apparently have no organic or functional background except that they date all their angiospastic difficulties to some trauma This traumatic group of vasoconstrictor spasms is an important one which is only imperfectly differentiated at present Undoubtedly many examples of it are being overlooked today Leriche<sup>10, 11, 12</sup> has particularly stressed its importance We have recorded two examples of traumatic vasoconstrictor spasm in a previous communication<sup>2</sup> We have repeatedly observed similar phenomena after different types of trauma, such as fractures, sprains, severe contusions, *etc*, as well as cases where the main nerve trunks are implicated as in causalgia discussed in the preceding section Ipsen<sup>13</sup> has also noted that the skin covering amputation stumps exhibits an accentuation of vasoconstriction, giving colder surface temperatures than is customary for that level of skin area

The following two case histories illustrate certain important points that we should like to emphasize in regard to this form of angiospasm consecutive to trauma

CASE VIII—M S M, Strong Memorial Hospital, No 3110, a twenty-one-year-old saleswoman, came to the hospital on account of pain in the left ankle Nine years previously this ankle had had an injury with the tine of a pitch-fork, and since that time she had more or less pain in this ankle which bothered her especially on walking The Rontgen-ray showed an area of increased density on the surface of the astragalus An exploratory arthrotomy was performed and the area was curetted out on December 17, 1926 Before operation there had been a little swelling and œdema present over the anterior surface of the left ankle but no abnormal coloration of the skin and no difference in the appearance or temperatures of the feet was noted The immediate post-operative reaction was not abnormal There was a moderate amount of swelling and pain in the ankle The unusual element in the case, however, was that when the patient was allowed up on crutches two weeks after operation, the discomfort in the foot and swelling around and below the ankle increased and the foot became extremely cyanotic and much cooler than on the opposite side Exposure to cold accentuated the cyanosis and coldness of this foot She was seen repeatedly over the next six months The same tendency to swelling, cyanosis and coolness of the foot remained unaltered for four months and then gradually began to diminish Whether or not this was a mere coincidence real improvement came with the advent of warmer weather At no time was there any evidence of a complicating infection

We have seen many other examples of a similar reaction to trauma in the extremities whether accidental or operative Usually this response is not as extreme as in the case cited, but it is frequently an annoying symptom for several months It is apparently due to an increased vasoconstrictor tonus in the involved extremity

CASE IX—C A E, Strong Memorial Hospital, No 30176, a forty-three-year-old laborer, injured the index, middle and ring fingers of the right hand on October 16, 1929, by getting them caught between two heavy stones. There was considerable pain and nausea following the accident, but the skin was not broken and the patient kept on working. No particular symptoms were noted by the patient for four or five days at which time the injured fingers began to ache and became extremely sensitive on exposure to cold. Tactile stimuli in this area also became painful. After exposure to cold, the involved fingers became a deep blue. Two weeks after the accident he stopped work on account of the pain in these fingers. We saw him first on December 3, 1929, when he had come in out of the cold weather. The distal two phalanges of the ring and middle fingers on the right hand were a very deep blue and at first glance appeared gangrenous. The rest of the hand was of normal color. On putting his hand under the warm tap water the intense cyanosis disappeared completely and was replaced by a bright pink color. On another day in a warm room a difference of three degrees in

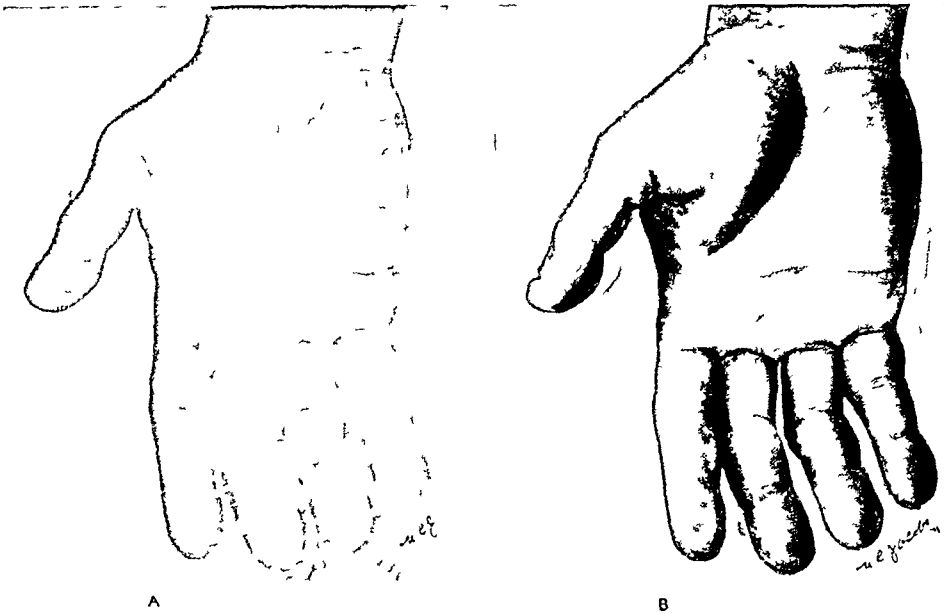


FIG 10—Case IX. Angiospasm post traumatic. (A) Fifteen months after trauma the effect of cold brings out ischemic areas on the ring and middle fingers of the right hand. (B) The angiospasm entirely subsides at ordinary room temperature ( $10^{\circ}\text{C}$ ).

the temperatures of the index, middle and ring fingers from the corresponding ones on the left hand was measured, while the temperatures of the little fingers were within one degree of each other. In a cold room this difference in temperatures between the involved and uninvolved fingers became considerably more. Hot and cold contrast baths to the part and Bier's hyperæmia were prescribed. Under this treatment his fingers improved somewhat and with the coming of warmer weather in the spring ceased to bother him. The following winter, however, with the advent of cold weather, he had a recurrence of his trouble limited to the terminal phalanges of the right ring and middle fingers. In these areas the ischæmia brought on by cold became so intense that anesthesia was produced, on one occasion to such a degree that, without realizing it, he burned the tip of his middle finger.

On January 30, 1931, fifteen months after the original contusion, he came into the hospital on a cool morning with an attack of intense pallor involving the terminal phalanges of the right index and middle fingers with a narrow band of marked cyanosis proximal to this (Fig 10). This area was  $6^{\circ}\text{C}$  colder than the corresponding area

# ANGIOSPASTIC SYNDROMES IN EXTREMITIES

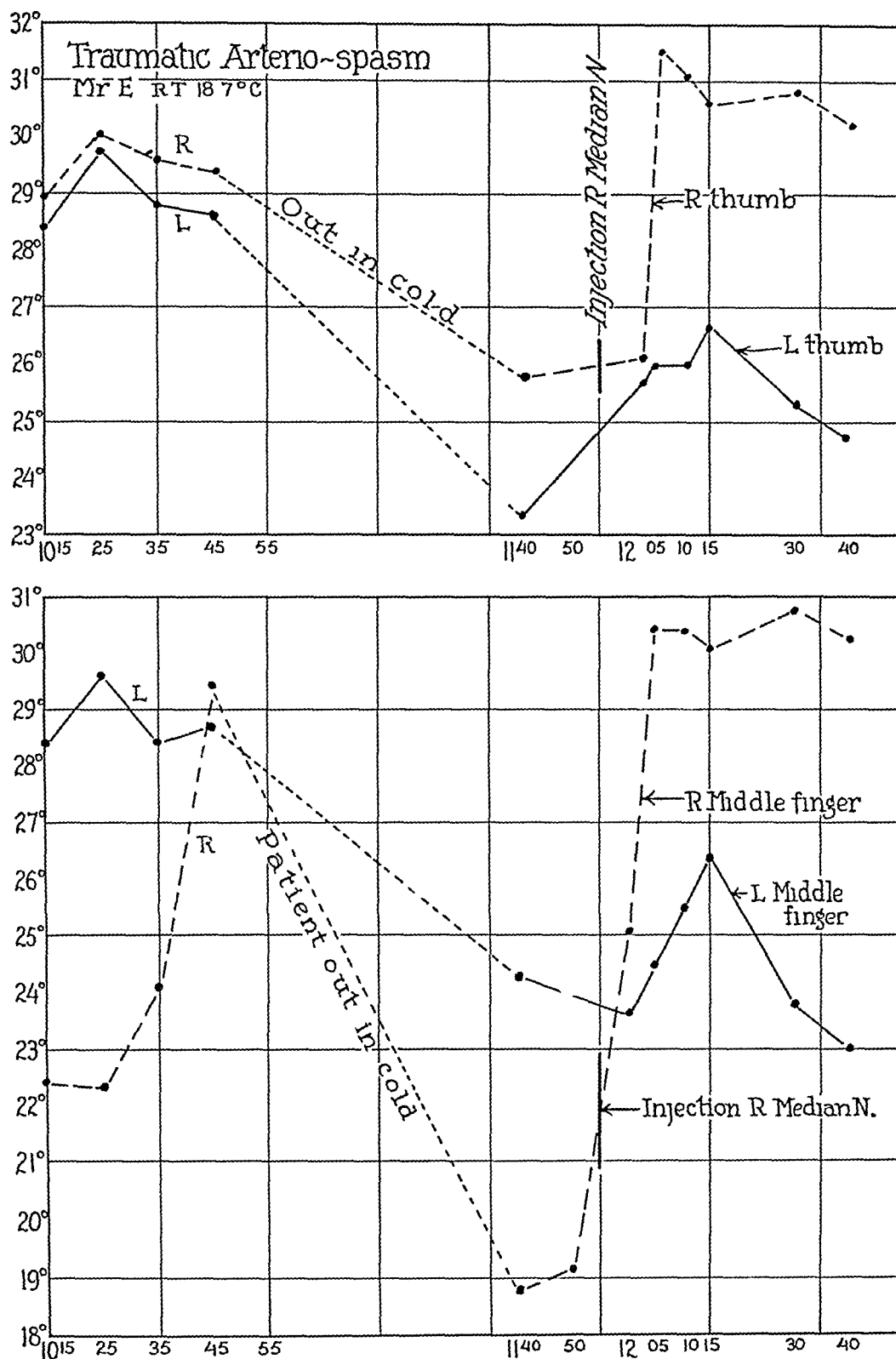


FIG 11—Case 1A Angiospasm post traumatic. Temperature determinations on the same patient as Fig 10. On coming in out of the cold note that the right middle finger is 6° C cooler than the left. At room temperature the spasm in the right finger rapidly subsides and its temperature comes up to the same level as on the opposite side. After exposure to cold this temperature difference is brought out again. Upon injection of the right median nerve the temperature of the right middle finger comes up to the normal vasodilatation level and is four degrees above the temperature of the left (normal) middle finger.



of the opposite hand. At ordinary room temperature ( $19^{\circ}\text{C}$ ) however, this angiospasm rapidly subsided and the temperature in this area came up to the same level as on the opposite side. The patient was again exposed to cold bringing back the difference. The right median nerve was blocked and the temperature rose rapidly to the vasodilatation level in the middle fingers going  $4^{\circ}$  above the temperature of the corresponding finger on the uninvolved and uninjected side (Fig 11). The patient has been followed and, with the coming of warm weather again, is free from symptoms.

Some of the outstanding points to be noted in angiospasm following trauma are (a) The hypersensitivity to cold, (b) the long duration of the

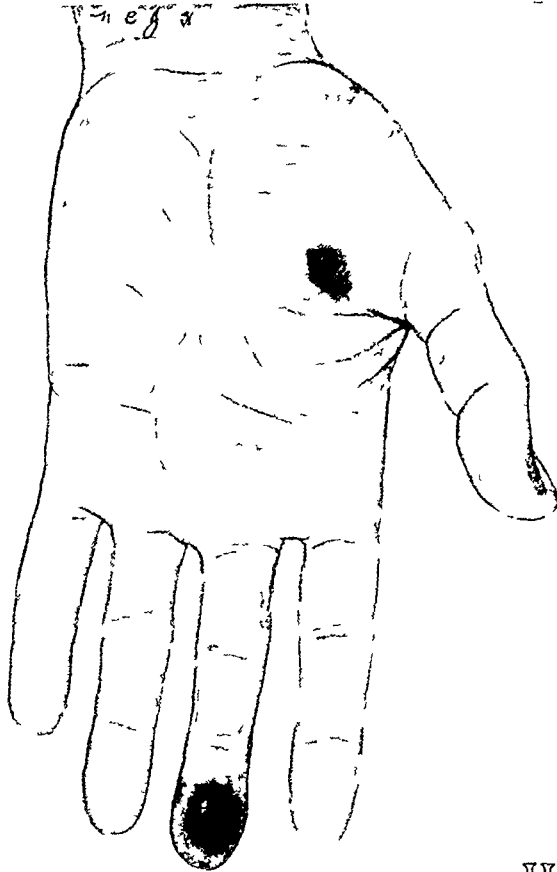


FIG 12—Case A. Venospasm. The principal lesion in the attack is on the left middle finger which is tense, congested and elevated above the surrounding level.

vascular spasm after the acute effects of the trauma have subsided and the injured tissues have been repaired by scar, and (c) the fact that this predisposition to angiospasm may pass into a latent stage and remain dormant for a long interval to be brought out again by certain conditions, particularly by cold. The frequency with which some degree of angiospasm follows many different types of trauma convinces us that an increased vasoconstrictor activity is a fundamental response to trauma and scar formation. We see this reaction definitely in causalgia when a nerve trunk is involved in the scar,

## ANGIOSPASTIC SYNDROMES IN EXTREMITIES

otherwise in the process of injury and repair it occurs without this obvious cause, though it is possible that the terminal nerve fibres are caught in the scar tissue. The cause for a trauma to result in a severe angiospasm or a long-standing susceptibility to it in one individual while in another this reaction quickly disappears is unknown. There is no definite correlation between the degree of the trauma and that of the angiospasm. It is probably true that a vasoconstrictor hypersensitivity is present in a latent form much longer and more commonly than is realized. Such a form is often passed over unrecognized as it requires the proper physical conditions to bring it out. The aching of scars on exposure to cold is probably to be explained on this basis. In regard to the treatment of those angiospasmic consecutive to trauma, we are at present being extremely conservative because most of them usually clear up under such a plan. We recognize the fact that certain cases may require temporary or permanent removal of sympathetic innervation. At present there are no satisfactory criteria to allow the proper selection of such cases. This group deserves further intensive study, as it is one of great clinical importance.

*Venospasm*—An unusual type of vasomotor disturbance recently came under our observation.

CASE X—P. W., Strong Memorial Hospital, No. 41961. This patient was a forty-nine-year-old housewife, who was admitted to the hospital on account of painful swollen areas on the left hand. The trouble began four weeks previously, when, following a manicure, she noted throbbing in the left middle finger. The pad of its distal phalanx became swollen, purplish, and exquisitely tender and painful. Since then she had had other similar areas at the base of the thumb and on the index finger. Neither of these had bothered her as severely as the one on the middle finger. The pain came in attacks preceded by swelling and intense congestion in the involved area. The congestion on the middle finger had become so intense that on two occasions a slight incision into it was made by other physicians. No pus was found at either time. The attacks of pain were particularly apt to come in the evening.

On examination, there was an intensely swollen congested area occupying about half of the palmar surface of the distal phalanx of the left middle finger (Fig. 12). There was also an area at the base of the thumb which was congested but not elevated. Measurement of the surface temperatures over the congested area showed it to be between one and one-half degrees warmer than the corresponding area on the opposite hand. This difference on the two sides was accentuated by immersion in water at 16° C. for ten minutes and the initial temperature was recovered over the involved area much more quickly (Fig. 13). This combination of paroxysmal intense congestion, purplish discoloration and evidence of increased warmth in the involved region (without infection) seems explicable only on the basis of a venospasm. The pain during the attack which the patient describes as throbbing in character is apparently due to the intense congestion in the area. This was so decided that it caused a marked local elevation. Either extreme of temperature was painful to the patient. The pulsations of the digital arteries of the involved finger were easily palpable, in fact, they seemed to be greater in the left middle finger than in the right. Careful search was made for evidence of any lesion that could be causing an irritation of the median nerve or its roots without finding any such cause. Our diagnosis was vasomotor neurosis, predominantly venous. With the patient quiet in the hospital the attacks of local swelling and pain diminished but later information in regard to the patient is to the effect that she is still troubled by them.

We have advised the patient to have the left median nerve blocked by novocaine in order to determine whether this would relieve the congestion and pain but she did not consent to this

Examples of true angiospasm on the venous side are certainly rarely recorded in the literature, and little is known about their cause and natural history. In this case it was our opinion and that also of the neurologic consultant that the venospasm was the expression of an underlying psychoneurosis. On the therapeutic side our endeavors were directed against the latter condition, but she did not stay under our care long enough to determine the final result.

#### CONCLUSIONS

(1) There are several types of angiospasm which can be recognized and

separated into major groups as follows: (a) In organic vascular disease, (b) idiopathic paroxysmal (Raynaud's disease), (c) dependent upon organic or functional nervous diseases, (d) consecutive to trauma, (e) venospasm.

(2) In Raynaud's disease the fundamental abnormality is a hypersensitivity of the peripheral arteries to cold. However, vasoconstrictor impulses play an important role by initiating and accentuating many of the attacks. Consequently, the advisability of removing the sympathetic innervation can be determined by the effect of regional anesthesia in releasing the spasm during an attack.

(3) Organic and functional nervous disorders frequently are accompanied by an accentuated vasoconstrictor tone locally.

(4) Trauma in the extremities may be followed by an arterial spasm, frequently associated with pain. This is probably due to vasoconstrictor impulses induced by reflex afferent stimuli from the traumatized area. We

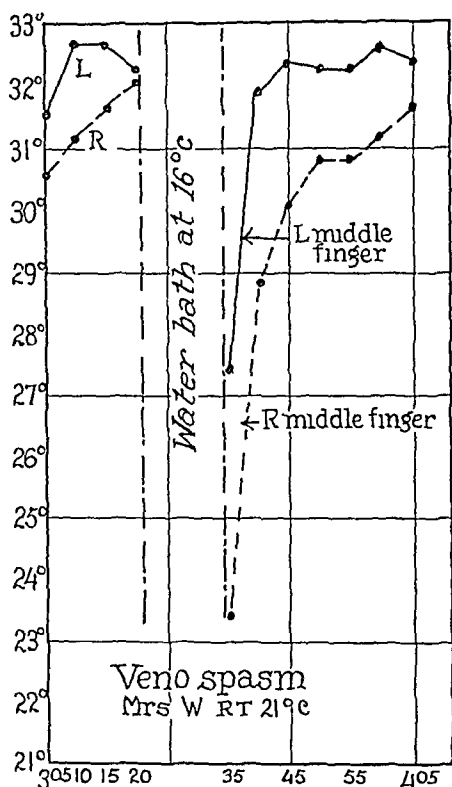


FIG. 13—Case 1. Venospasm. Surface temperatures on the middle fingers. Note that the involved side is at a higher temperature both initially and immediately after immersion in a cold water bath; also that it recovers its pre-immersion level much more quickly.

believe that such a reaction is a fundamental response incident to trauma and scar formation. There is an individual variation in the degree of manifestation of this reaction and it may be present as a latent hypersensitivity to cold.

(5) Evidence is presented that angiospasm affecting principally veins occurs as a clinical entity.

# ANGIOSPASTIC SYNDROMES IN EXTREMITIES

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# THE DIAGNOSIS AND PRINCIPLES OF TREATMENT OF CARCINOMA OF THE COLON AND RECTUM

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WE HAVE been discussing a subject which should command more attention than has been given to it by the medical profession in general, and this lack of attention starts in the medical schools many times. The importance of a disease should be determined by the value of treatment in prolonging life and in making it more comfortable for the patient rather than by the number of cases seen. If we compare the results of treatment in cancer of the colon and rectum in prolonging life and making it more comfortable with the results of treatment of other serious diseases, we must come to the conclusion, I believe, that it stands high on the list of important diseases. That the disease should stand high among important diseases is shown by the fact that although the diagnosis is made so late in the course of the disease (25 per cent to 50 per cent of those seen are operable), between 45 per cent and 50 per cent live in comfort for five or more years.

That carcinoma of the colon and rectum is not considered one of the important diseases is well illustrated by the Massachusetts statistics. There are, in Massachusetts, 11,000 deaths from carcinoma each year, and of these about 12 per cent are in the intestine, that is, about 1,200 cases of carcinoma of the colon and rectum die each year. After considering the work of various hospitals, it is difficult to believe that there are more than 150 radical operations, probably less, each year. It is evident, therefore, that about 10 per cent of the patients with this disease are given a chance for life and comfort. It is possible that 50 per cent of the patients in the state get either a radical or a palliative operation, many, therefore, are given no opportunity to be more comfortable and undoubtedly many get no consideration by a competent authority. It is probable that not more than 60 patients out of the 1,200 live five or more years.

The waste of life then is very considerable not to mention the great amount of suffering that might be avoided, largely because the physicians and surgeons of the state do not have it impressed upon them that cancer of the colon and rectum is a disease of importance, because it can be treated with considerable success. It would not be a wild dream to believe that more than 75 per cent of all cases would be suitable for radical operation if general interest could be aroused, but, of course, it is useless to expect any sudden change in the interest shown in these cases or in the ability to diagnose them. The surgeon must first become interested in these cases in order to stimulate others. He must show physicians that he can operate with a reasonable mortality and must be able to show that patients live comfortably for a reason-

able length of time We have scattered over the country at present a small but increasing number of surgeons who take an interest in the subject

Up to quite recently patients, physicians, and, I am sorry to say, surgeons have felt perfectly hopeless about the value of operation for carcinoma of the colon and rectum In consequence of this lack of interest by the surgeons, no interest has been taken in the early diagnosis, in consequence of which patients have been treated by palliative operations only While a positive diagnosis may at times be difficult, it is quite evident that it is not the difficulty of diagnosis but rather a lack of interest which is responsible for the great delay in the treatment of these cases Recently some interest in this condition has been aroused in a small group of physicians, and unless the surgeons rise to the occasion and are ready to attempt radical operations, these physicians will soon lose interest and we shall drop back to where we were a few years ago A recent paper stimulated the physicians of a section of Massachusetts to look for these cases They were rewarded by finding several, but as one of the physicians complained, "I have sent my cases to surgeons, but they have attempted nothing but a colostomy on any one of them"

While interest in this disease is the most important factor in early diagnosis, we cannot hope to progress much so long as the brains of medical students are filled with exceedingly interesting (at least to the teacher), rare, and hopeless cases instead of teaching them the diagnosis of carcinoma of the colon and rectum At a recent meeting in a teaching hospital a group of most unusual and hopeless cases were shown, and the surgeon assured us that he had arranged to have hæmorrhoids and fistulæ sent to another non-teaching hospital so that he could take in the unusual cases When we consider that about 75 per cent of the cases of carcinoma of the rectum are first diagnosed as hæmorrhoids, how are the students to learn anything about carcinoma of the colon or rectum in the teaching hospital?

The diagnosis of these conditions should be of great importance to physicians as well as surgeons The usual list of symptoms as given in the textbooks is not sufficiently clear to the average physician for him to make a diagnosis, because many of them are of little or no value If it could be taught that any change in bowel habit or sensation or bleeding from the rectum is suggestive of malignant disease of the colon or rectum, it would not be necessary to burden students and physicians any further A group of students going out with this impressed upon them would soon teach it to their patients and difficult cases could then be sent early to competent authorities for diagnosis The great difficulty is that this statement is so simple few would really accept it for fear of disturbing patients if there was no disease present

The question of blood in the stool is of great importance when properly considered and especially is it of importance to the internist and family physician who are the first to see these cases, and yet it is so firmly impressed upon them that hæmorrhoids are the important cause of bleeding that blood

in the stool is of little or no value in diagnosis to the average physician or layman

If all schools could send their students out with the idea that bleeding from the rectum means carcinoma of the colon or rectum until it is definitely proved in a particular case that it is not, a great advance would be made. I asked a class of 100 students the other day the most important cause of bleeding from the rectum and was told that it was hæmorrhoids.

Much has been said recently about bleeding in cases of diverticulitis of the colon. So far as can be made out from statistics, bleeding associated with diverticulitis of the colon alone occurs in about 5 per cent of these cases. It is evident, therefore, that great care must be taken to avoid overlooking carcinoma of the colon when there has been bleeding and a diagnosis of diverticulitis has been made by X-ray. In my own cases if I had depended on the X-ray diagnosis of diverticulitis with bleeding, an error would have been made in 75 per cent of the cases, while if operation had been carried out in all these cases, the operation would have been an error in but 25 per cent. It is exceedingly dangerous to make a diagnosis of diverticulitis of the colon even with the aid of the X-ray when there is bleeding associated with it.

Symptoms which are still spoken of as of great importance are The "ribbon" stool, constipation, alternating constipation and diarrhœa, diarrhœa alone, loss of weight, and pain. The ribbon stool may be thrown out as of no value. Constipation in these days of oils often passes unnoticed. It may be true that there is alternating constipation and diarrhœa, but so long as the patient does not recognize it, why should we consider it of importance? The patient may become constipated, but if he does he frequently takes oil which relieves, usually without diarrhœa. At times the constipation may be more marked, he then takes a cathartic and has several movements which he attributes to the cathartic and he does not speak of it as diarrhœa, nor does he appreciate that it is alternating constipation and diarrhœa. When the growth is low or causing marked obstruction, there are often many small movements or the patient goes to stool frequently to get rid of mucus and usually blood, but he does not recognize this as diarrhœa. Loss of weight is of little value as a symptom as it rarely occurs until after the obstruction is marked. There is then at times loss of weight due to loss of appetite, but rarely loss of weight due to the disease. Pain does occur frequently, but it is before the patient reaches the physician usually. Later in the course of the disease the patient does not complain of pain, but will admit that there is much disturbance from gas, not pain. Occasionally there are repeated attacks of pain with comfort between the attacks. These are frequently overlooked or considered to be of no significance unless they are unduly prolonged. It will be seen, therefore, that many of the symptoms as given in the older textbooks are really of little value in making an early diagnosis.

If carcinoma of the rectum is suspected, the diagnosis can be made, in 100 per cent of the cases presenting themselves, by digital or sigmoidoscopic examination. I have no hesitation in urging that no X-ray examination be made

until carcinoma of the rectum has been ruled out by these examinations, for why should we use an uncertain method in place of an absolutely sure one?

In suspected carcinoma of the colon our greatest aid to diagnosis is undoubtedly the X-ray, but it must always be used in connection with the history and physical findings. X-ray examination alone leads to many errors in spite of the fact that many clinics report a correct diagnosis in from 85 per cent to 95 per cent of the cases examined. This does not mean that the X-ray alone has made a correct diagnosis in such a high percentage, but probably means that the surgeon has made a correct diagnosis with the history, physical findings and X-ray examination, while many depend upon the X-ray examination alone.

It is my belief after seeing many X-ray reports on these cases that a correct diagnosis is made in not more than 75 per cent of the cases by the average roentgenologist. In the clinics in which the higher percentages of correct results are made, it is probable that no allowance is made for the cases which leave that clinic with a clean bill of health and are later found to have carcinoma of the colon, nor does it account for the cases which are diagnosticated as diverticulitis but later are proved to be carcinoma.

The percentage of correct results in many clinics in carcinoma of the rectum is so low that an X-ray should not be used. Proper digital and sigmoidoscopic examinations will always make a diagnosis of carcinoma of the rectum and rectosigmoid. It is undoubtedly true that sigmoidoscopic examinations have been much neglected in carcinoma of the colon as well as of the rectum. The growth cannot always be seen, but frequently the determination of blood in the rectum and the direction from which it comes is of great value. Frequently when the growth cannot be seen, a fixed mass can be felt with the sigmoidoscope. The presence of ulcerative colitis, polyps, tuberculosis, and other ulcerations in the rectum may be found an aid in ruling out carcinoma above. Examination of a patient who has been bleeding recently will often aid one in determining that the blood is coming from the hæmorrhoidal area even though the hæmorrhoid is not bleeding at the time.

Papillomatous and adenomatous polyps, when found, should be considered as potential or actual carcinomata. It is impossible in many cases to determine as to whether or not they are already carcinomatous by removing a section. A useful method of determining the character of the growth is to remove it with the high frequency cautery and then examine the base with a proctoscope at weekly intervals. If the base heals smoothly and remains so, the diagnosis of simple polyp may be made while if a granulating area remains, a section can be removed and the character of the growth determined accurately.

A source of error in these examinations is the fold on the anterior surface of the rectum at about 15 centimetres above the external orifice when the patient is in the knee-chest position. It is quite possible to cover a polyp or a small carcinoma here with the end of the sigmoidoscope and overlook it entirely unless great care is taken to examine as the instrument is withdrawn.



It is my opinion that more errors are made because of inability to see the whole surface of the rectum and lower sigmoid than for any other reason. It is not sufficient to have the bowel free from large masses of fæcal matter, the mucous membrane must be carefully wiped in order not to see ulcerations where there are none. Ulcerative colitis has been reported when frequent movements with blood are present because of this error.

In the final summing up of a case in which carcinoma of the colon is suspected, it must not be forgotten that an exploratory operation is not a serious matter. We must not forget how easily we advise operation for a suspected chronic appendix or for a so-called chronic cholecystitis. It is of much greater importance to explore when carcinoma is suspected.

In regard to the treatment of carcinoma of the colon and rectum I feel that there should be some standardization or at least some agreement as to the fundamental principles of the treatment of carcinoma of the colon and rectum. I am quite in agreement with Doctor Turner when he said at the meeting of the American College of Surgeons last October "Personally I have a great distrust of so-called standardization in dealing with human beings and pathologic conditions." I feel, however, that we must agree upon certain fundamental principles. Another statement which Doctor Turner made in the same address proves the necessity for coming to some agreement. He said "The history of surgery of malignant disease is neither so discouraging nor so discreditable as many would have us believe, for it shows that when efforts of the surgeon have been sufficiently thorough, the results have often been commensurate with the sacrifice which the patient has had to make."

The fundamental principle to be settled is: What is a "sufficiently thorough" operation? This has been answered in the past and even up to the present time by two opposing groups. The first group states that carcinoma of the colon and rectum metastasizes late or not at all and therefore a local operation is sufficient. The second group believe that patients with carcinoma of the colon and rectum should be treated as are patients with carcinoma in other organs, that is, the growth should be excised by a wide margin and the area of lymphatic drainage removed with it so far as possible. It is quite evident that surgeons have never agreed upon what is "sufficiently thorough." Czerny in 1883 reported upon a combined abdomino-perineal operation for cancer of the rectum, but surgeons were not ready for so extensive an operation. In 1911, Miles, of London, after a careful study of cancer of the rectum, presented his combined abdomino-perineal operation for cancer of the rectum and gave excellent reasons for it. This brought forth a great many protests against such an extensive and mutilating operation and there were many statements similar to that of Doctor Paul, of Liverpool, who, in 1912, said "Why should we undertake an extensive excision of the mesentery for the removal of glands which in all probability are not infected?" One English surgeon some years later said that so far as he knew, all his cases were alive and well after excision by the posterior route. It is only rarely that I

have read a paper on the subject that one or more surgeons have not reported a case which had lived fourteen years after a local resection

At the meeting of the American Surgical Association in 1929 in the discussion of the papers on cancer of the rectum, no one spoke of the value of the abdomino-perineal operation, but several reported a case alive five ten, or more years after a local resection or what might be considered an inadequate operation. We were told at the same time that cancer of the rectum is an entirely different type of cancer, that the glandular distributions of the rectum are not like those of the breast or neck, and because the lymphatics intertwine between the bladder, uterus, and rectum, it is difficult to do a radical operation. Henri Hausmann about 1911 reported that of 112 patients dying of carcinoma of the colon the growth was still limited to the bowel in 50 per cent of the cases. The Mayo Clinic report that in only 43 per cent of the cases of cancer of the colon operated upon are metastases found in the glands.

What have all these statements to do with the proper treatment of cancer of the colon and rectum when it can be proved by statistics that not 10 per cent of the cases seen are alive ten years later? The implication that a local or restricted operation gives as good results as an extensive operation because a surgeon here and there has had a patient live five years or more after a local or restricted operation is without foundation in fact. No group of cases in which a local operation has been done has been presented with all the facts necessary to determine the value of it. I am sure that many can match every case that has lived five years after a local operation with many cases that have died within two years because of local or inadequate operations. If the statement were accurate that there are no metastases outside the bowel in 50 per cent of those coming to autopsy or that metastases are present in the glands in only 43 per cent of those operated upon, we should be able to cure permanently between 50 per cent and 100 per cent of all cases seen, while as a matter of fact not 10 per cent of the cases seen live ten years. Before statements about the value of any operation are made, we must know the type of growth and extent of local disease, the percentage of cases operated upon, the mortality, and the number of patients living in comfort three, five, or more years. If we are to believe that there is great value in a local resection or any operation less than a combined abdomino-perineal operation, then a large series of cases should now be reported in order that we may know what percentage can be operated upon and remain well for three, five, or more years.

If surgeons had the temerity, it is probable that many could report cases of carcinoma of the breast cured by local operation, but in carcinoma of the breast the extent of the operation is well established, while in carcinoma of the colon it is still legitimate to report a cure following a local operation as evidence that an extensive operation is not necessary. As to the network of lymphatics which intertwine between the uterus, bladder and rectum, it may be true that they do, but for practical purposes there is very good evidence

that these regions are not involved in many cases as shown by results in the more extensive operations. Do we not have the supra-clavicular glands and the lymphatics of the breast connecting with those between the ribs as well as other channels, as pointed out by Sir Sampson-Handley? Do we perform a local operation on cancer of the breast because of these inaccessible lymphatics? Is it not reasonable that we should treat cancer of the colon and rectum as we do cancer in other parts? Is it not time that we considered this subject from the point of view of the results obtained by the various operations? Is it reasonable that we should consider the value of an operation from results in two or three cases when they have been selected from 100 or 125 as has been done in many reports on the lesser operations? Should we not determine by statistics the operation which can be done with a reasonable mortality and which gives us the largest number of patients out of the total number seen, who have lived three or more years?

These reports of small series of cases treated by local or restricted operations without stating the percentage they are of the total number seen are discouraging to those trying to improve results and to operate upon a larger percentage of cases, and it makes it difficult to do any operation other than the limited ones reported because physicians and patients hear of them and will not submit to the more extensive and, I believe, better operations in most cases. I have met one man who is at least honest in the matter. He admits that he amputates the rectum by the posterior route because his mortality is lower than with the more extensive operations, and as his mortality is lower, it makes a better impression on the community even though the late results may not be so good.

We must admit, I think, until statistics prove otherwise, that the more extensive operations which include removal of the area of lymphatic drainage are the ones which should be undertaken when possible and that the experience of the surgeon and the condition of the patient are the only valid reasons for a lesser operation, except in an occasional carefully selected case when the type and extent of the disease are determined by an experienced surgeon.

Professor Grey Turner, in his address, stated that he had done fourteen local resections for cancer of the rectum. Four died within a year and nine months and five have been operated upon less than three years. While this seems to be quite a series, Professor Grey Turner, in a personal statement, told me that this list comprised between 2 per cent and 3 per cent of the total number of operations for cancer of the rectum, not a large enough percentage to make local resection a very valuable operation and yet one which has been advocated by several surgeons as the operation of choice.

We should not object to a surgeon selecting the operation which he is capable of performing, nor the operation best suited to the condition present or to the ability of the patient to withstand any particular operation. We should object to the statement not backed by statistics that a lesser operation is as good as or better than a more extensive one. It may be true that there

is little use in attempting an extensive operation when the glands are involved, no series of cases has been presented to prove it, but if it is true, how are we to know when the glands are involved? In addition, many can report cases in which metastatic glands were found at operation and yet the patients have lived three, five, or more years

It may be stated that at the time many of these statements in regard to carcinoma being a local disease were made, 25 per cent or less of the patients seen were operated upon and not more than 25 per cent lived three or more years. With the more extensive operations from 32 per cent to 50 per cent of the cases seen are operated upon, and of these over 60 per cent live three or more years

It is my hope that we can all agree upon the necessity of removing the growth with a wide margin at either side, and that the area of lymphatic drainage should be removed when possible. It may be admitted that a lesser operation must be performed many times and that such an operation is better than none. If we could agree upon the principles of the combined abdomino-perineal operation of Miles for cancer of the rectum as coming nearest to the ideal at the present time, we would have accomplished much. It is quite easy to agree that an occasional case does not require such an extensive operation if the type of growth is Group I or II and if an experienced surgeon selects the cases for restricted operation. It is also true that certain patients are not sufficiently strong to withstand the ideal operation and many surgeons have not had sufficient experience to undertake it. We must, therefore, have operations for the patient who is below standard and for the surgeon of little experience

In carcinoma of the colon we might assume that the ideal operation is excision of the growth with a wide margin and with all the mesentery of that portion of the bowel followed by an end-to-end suture, but here again we must have operations to meet the condition of the patient and the experience of the surgeon. We believe that the Mikulicz operation which is so strongly urged by some surgeons is frequently not applicable because it does not permit removal of a sufficient amount of bowel and mesentery. Given a patient in reasonably good condition, we believe that the only guide to the choice of operation should be the ability to remove a sufficient length of bowel and its mesentery. That is, in spite of the fact that the Mikulicz operation gives a much lower mortality, it should not be used unless a sufficiently wide margin of bowel and a large mass of mesentery can be removed

There can be little doubt but that the controversy as to what is a "sufficiently thorough" operation for cancer of the rectum is kept up largely by those who object to the removal of the sphincter. Many of these surgeons are so opposed to it that they prefer to let the patient go on until a colostomy alone is necessary rather than make the patient comfortable or possibly cure him by removal of the growth and sphincter. Some of these surgeons, feeling that resection and preservation of the sphincter is so important, rarely find a case suitable for any operation if it is not suitable for resection

In regard to the necessity for a colostomy in the great majority of cases, I believe that Turner, in his address to the American College of Surgeons, made a very significant statement when he said "When efforts of the surgeon have been sufficiently thorough, the results have often been commensurate with the sacrifice which the patient has had to make" If this statement is true of malignant disease anywhere, it is true of carcinoma of the rectum It may be a sacrifice to have a colostomy, but I thoroughly believe that the results are commensurate with the sacrifice This of course assumes that the surgeon will teach the patient how to care for the colostomy, as almost the only patients who complain of their colostomies are those who have managed them according to their own ideas, that is, with cathartics It is the duty of surgeons who operate upon carcinoma of the rectum to learn how to care for colostomies, for there is no mechanical method of controlling them in spite of all the operations that have been devised, and to learn from experience with patients their feelings in regard to colostomies, and not to allow sentimentality to keep them from doing a "sufficiently thorough" operation A colostomy is necessary in the great majority of cases The sphincter may be preserved in a small percentage only when the growth is quite early and the selection made by a man of great experience

Most physicians and many surgeons obtain their experience in regard to colostomies from those patients in whom the growth has not been removed Those who have had experience with colostomies after removal of the growth look upon them as a rule in an entirely different light I may say that after seeing about 300 patients who have had a colostomy and the growth removed I can state that I have not seen a patient who has not lived happily and contentedly I have never known a patient to commit suicide after removal of the growth and a colostomy, but I have known of two or more who have committed suicide who have not been operated upon

This is not a plea for the combined abdomino-perineal operation in every case, but a plea for a "sufficiently thorough" operation for every patient who can stand it It is my belief that the saying that the smaller and the earlier the growth and the better the chances for a cure, the more extensive should the operation be, holds good today as well as formerly

In dealing with carcinoma of the colon and rectum, I believe it is important for the surgeon to consider these cases from the point of view of making the patient comfortable rather than from the point of view of cure If we operated only upon those patients who we think can be cured, there will be a large number of patients who could have been made comfortable for one, three, or more years who will not be operated upon It is my opinion that comfort for one year is worth more than the discomfort of the operation

While it is not possible to standardize the technic in resections of the colon, two fundamental principles might be agreed upon (1) An adequate blood supply is a necessity, and (2) the line of sutures must be relieved of intra-intestinal pressure We have, I believe, spent too much time on the consideration of the suture material, aseptic methods of anastomosis, and the

advantages of an end-to-end suture over a lateral, or vice versa, while as a matter of fact the one essential always to an immediately successful operation is an adequate blood supply to the portions of the bowel to be sutured

There are two problems in the blood supply to the portions of the bowel to be united. Jamieson and Dobson have shown that theoretically all portions of the colon should be supplied by any two of the main arterial branches to the colon through the vascular arches which connect the right, middle, and left colic arteries and the superior hæmorrhoidal artery. While this may be true if there are no anomalies, some of us have found that anomalies do occur and before any main artery is tied we must always be sure of a sufficient blood supply beyond. Jamieson and Dobson have also demonstrated that if the superior hæmorrhoidal artery is tied above the last branch to the sigmoidal arches, there need be no fear of a lack of blood supply to the lower sigmoid or upper rectum. This again may be true theoretically, but how often can we depend upon our accuracy in selecting the proper place to tie the superior hæmorrhoidal? It must be remembered that the life of the patient depends in most cases upon the accuracy of placing this tie, for necrosis will surely follow if the branch to the arches and the terminal portion of the superior hæmorrhoidal artery are tied. From experience with the combined abdomino-perineal amputation of the rectum I am convinced that in resections of the sigmoid there will not always be sufficient blood supply to the proximal end of the distal fragment from the middle hæmorrhoidal arteries even if these branches are not tied. It is probable, but not always certain, that the proximal bowel in resection of the sigmoid will receive sufficient blood supply if the inferior mesenteric artery is tied above the left colic branch. I have already had a case in which the inferior mesenteric was tied above the left colic in which there was necrosis of the whole upper sigmoid from the colostomy to the middle of the descending colon. Probably one of the most important factors in necrosis is injury to a perpendicular branch or branches close to the cut edge of the bowel. Injury to the first and second branches above the line of section will at times cause necrosis of one-half inch as was demonstrated by tying the perpendicular branches at the end of a colostomy. Another bit of evidence that the vessels are of importance is, I believe, shown by the less frequent leakage following a lateral anastomosis than after an end-to-end suture. The best suture material and the best suture known, the most carefully done anastomosis or an aseptic anastomosis are of no value if the blood supply is deficient.

The next most important fundamental principle in resections of the colon is the prevention of intra-intestinal pressure on the line of sutures. This has not been considered of sufficient importance to demand a sure remedy until quite recently, and even today many surgeons do not feel the necessity for carrying out this principle. It is true that many cases will do well with no particular provision for the prevention of pressure, but here again what we need are statistics to prove the value of this principle. We believe that the surest way to prevent pressure on the line of sutures in the left colon is to

make a colostomy a short distance above the line of suture, but we believe that a cæcostomy made by infolding the cæcum about a tube one-half to three-quarters of an inch in diameter is effective, never interferes with the field of operation, is sufficiently effective in emptying the bowel before operation and requires no secondary operation to close it

There are other methods of preventing pressure upon the suture line, but they are not so effective as a safety valve as the cæcostomy or colostomy. Morphia has much value in keeping down violent peristalsis and it is the simplest method. Proper preparation of the bowels before operation as suggested by Rankin has its value, but it cannot be depended upon alone in all cases. In low resections with end-to-end anastomosis a three-quarter inch tube may be put in through the anus and through the anastomosis, but to be effective, the bowel must have been thoroughly cleansed before operation. It is true that many patients have lived after resections when nothing has been done to prevent intra-intestinal pressure, but is that a good reason for continuing a procedure which may bring disaster in any case?

As to other points in technic, they are of so little importance as compared to a proper blood supply and the prevention of intra-intestinal pressure that they will not be taken up. It may be said that so much stress has been laid upon the aseptic method of anastomosis by some authors that the two important factors in good results, blood supply and absence of pressure on the line of sutures, have been lost sight of.

As to drainage following suture, there will always be a controversy. It may be said, however, that fewer cases are drained than formerly.

# THE RELAXATION OF SCAR CONTRACTURES BY MEANS OF THE Z-, OR REVERSED Z-TYPE INCISION

STRESSING THE USE OF SCAR INFILTRATED TISSUES

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THE purpose of this paper is to call attention to a method by which flaps of scar tissue or of tissue considerably infiltrated with scar may be used in relaxing scar contractures. The utilization of such tissue for the relaxation of scar contraction is not generally understood although the Z-type incision by which it is accomplished is an old procedure.

It is a good plastic principle to remove all scar tissue before attempting any sort of reconstruction and this should be carried out whenever possible. However, there are many contracted scars where complete excision of the entire scar is impracticable on account of its extent and location. In these instances, unless skin grafting or flap shifting from a distant part is done, it is necessary to utilize scar or scar-infiltrated tissues, and often a great deal can be gained and much relief given by the proper use of such tissues.

In order to utilize flaps of scar-infiltrated tissue some manœuvre must be carried out which will relax the contracted band and break the line of scar tension. In suitable cases, this may be accomplished by the use of the Z, or reversed Z, or staggered Z, or S, or reversed S-incision as one may choose to call it.

The transposition of the flaps thus formed is made possible because there is always shortening of the tissues in the direction of the contraction and usually excess or fullness on both sides of the contracted band.

*History*—A review of the literature was made by Dr Herbert Wilgis and myself in order to determine, if possible, who first devised the Z-type incision and transposed the flaps thus made. As far as we can find, the earliest description of this incision with the transposition of the flaps thus made was by Denonvilliers in 1856, who apparently developed the procedure in steps. He used it successfully for the relief of ectropion of the outer third of the lower lid. This type of incision may have been used even before Denonvilliers, but we were unable to find an earlier report.

Szymanowski, in his book published in 1870, illustrated the use of a similar incision for the relief of a deviation of the angle of the mouth so the method was well known to him. Piechaud reported in 1896 the use of a modified Z-type incision for the restoration of the axilla and for the relief of scar contractures in other regions. He stressed the utilization of scar-infiltrated tissues and apparently made considerable use of the method. Berger and Bonset in 1904 used a Z-incision with the transposition of flaps for the restoration of an axilla which had been obliterated by scar contrac-



ture Berry and Legg in 1912 employed the Z-incision for adjusting the vermillion border in a poorly repaired congenital cleft of the lip

McCurdy in 1913, in 1917, and again in 1924 wrote on the Z-plastic method and emphasized the importance of implanting in the centre of the wounds flaps of normal skin and of shifting the burn scar to the ends of the field of operation Morestin in 1914 described a method of relaxing a permanent flexion of the finger due to scar tissue by the use of a multiple Z-incision An incision was made along the rim of the scar bridle dividing

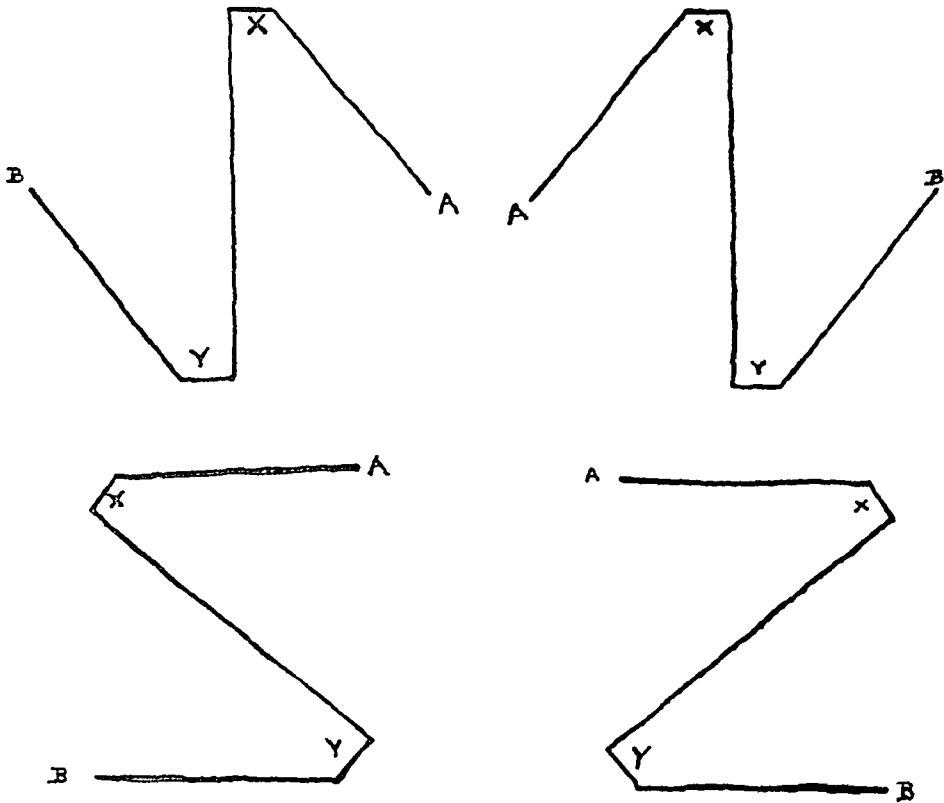


FIG 1—Illustrating the Z and reversed Z type incision In the diagrams the length of the corresponding lines making the incisions are the same although they appear to vary considerably on account of the tilt of the figure The longest line of the Z may be in any direction in which the scar contracture happens to be and the arms of the Z will necessarily change their direction to conform with this In each of the diagrams after the blunt pointed flaps outlined by the incisions are raised and transposed the tip X is sutured into the angle formed at B and the tip Y into that at A The line AX being sutured to the BY

it into two leaves, then from this central incision several lateral incisions were made forming a number of flaps The finger was straightened and the flaps were drawn into the angles formed by the incisions made on the opposite side In this way the scar bridle was released and the scar pull broken by a very irregular closure This procedure was well illustrated diagrammatically by Rahm in 1923

Frank S Matthews in 1915 illustrated a modified Z-type incision for liberating a band of scar tissue which was quite similar to that used by Piechaud, but was devised without knowledge of Piechaud's work Pieri in

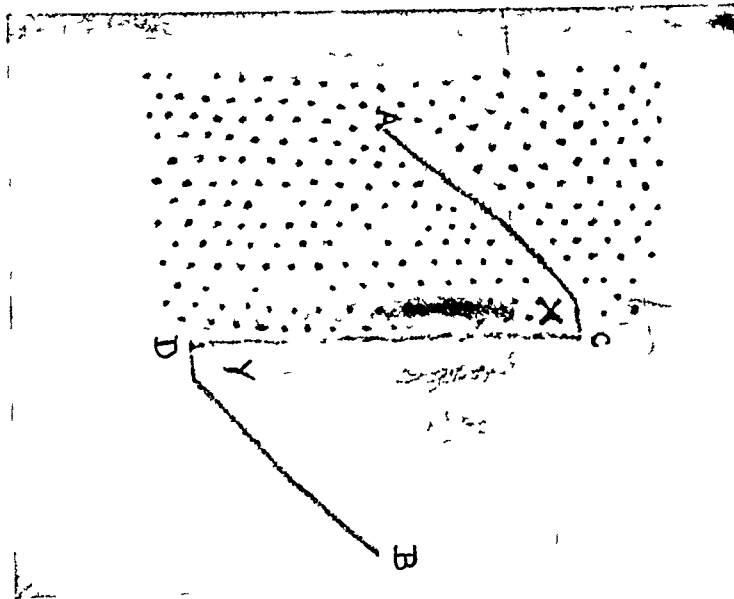


Fig 2a

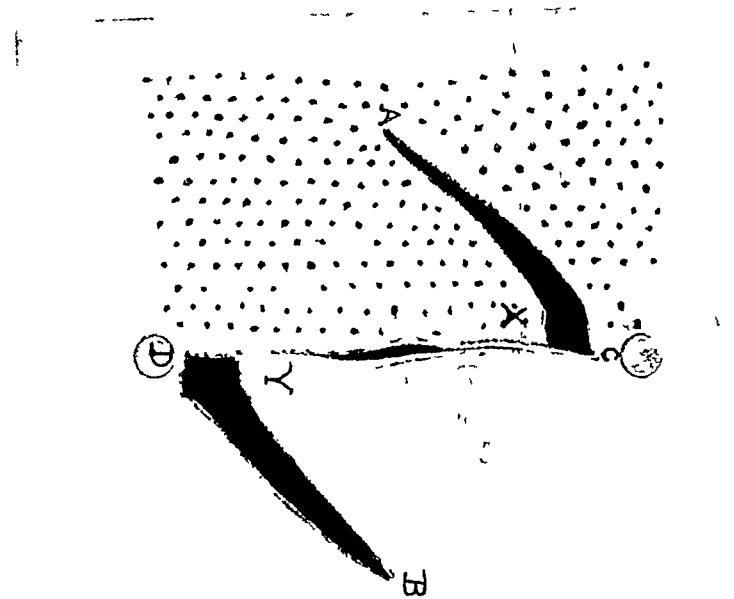


Fig 2b

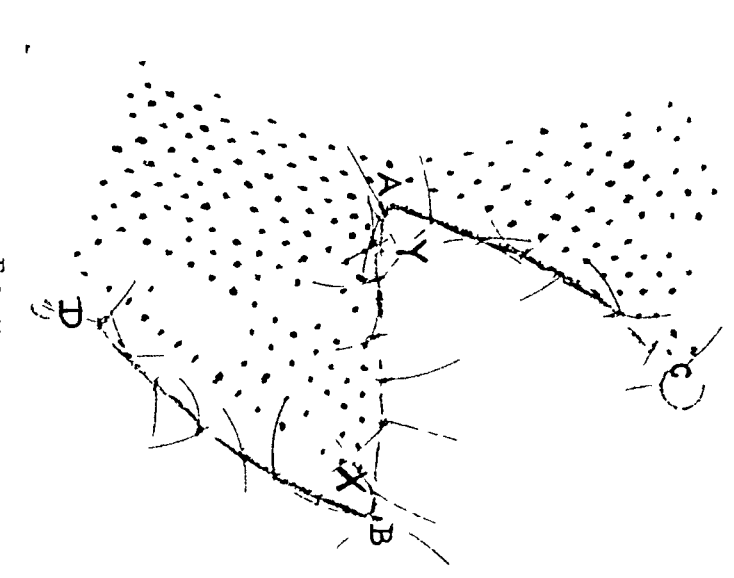


Fig 2c

Fig 2a—Demonstrating the Z type incision which we have found most generally useful with the transposition of flaps. A piece of chamois skin was placed on a frame and the central portion was stretched snugly between two thumb tacks to represent a scar bridle. Note the 'scar bridle.' CD which projects quite markedly. Along the center of this bridle is the longest line of the Z, the arms of the Z, DB and AC, are marked out so that the tips of the flaps X and Y will be blunt. A portion of the skin has been dotted in order to show contrast after the flaps are transposed.

Fig 2b—Illustrating the shrinkage of the flaps after the Z incision has been made. The incision has been made along the Z previously marked out ACDB and the flaps X and Y lie completely separated and theoretically undercut. Note the gaps along the arms of the Z which in a real scar are often much more marked as naturally.

Fig 2c—Illustrating the transposition of the flaps after transposition. Note the position of the flaps after transposition. The flap X made in the dotted portion of the skin being drawn into the defect made by raising the flap Y in the undotted portion and vice versa. The tip of the flap X being sutured to the point B and the tip of the flap Y being sutured to the point A. Note the approximation of the edges of the flaps with horsehair sutures, the edge AC of the dotted flap X being sutured to the thumb tacks BD of the undotted flap Y. The breaking of the 'scar pull' and the relaxation of the bridle can be well seen. Note the increase in the distance between the thumb tacks as the relaxation obtained by the transposition of the flaps made it necessary to move them outward to the edges of the frame also that the suture line is the slackened reverse of the original incision.

1919 illustrated the application of a modified Z-type incision with the transposition of scar flaps in deepening the commissures on badly mutilated hands. Davis illustrates the Z-type incision several times in his book on Plastic Surgery, published in 1919, and also in a paper on Arm-Chest Adhesions in 1924. He again demonstrated the use of this method on the face and neck in 1930 in the Section on Plastic Surgery in Dean Lewis' System of Surgery.

Steindler in 1923 illustrated his idea of Pieri's operation in relaxing a scar web on the thumb by the use of a modified Z-type incision and also showed an excellent illustration of the relaxing of a web between the thumb and forefinger by a Z-incision. Bosch Arana in 1925 wrote on the use of a modified Z-incision with the transposition of flaps in the phalangization of



FIG 3a

FIG 3b

FIG 3c

Illustrating the use of the Z type incision on the neck.

Figs 3a and 3b—Old burn scar of neck. Note the width of the bridge and the extent of the scar.

In this case a Z shaped incision was made and the flaps were transposed.

FIG 3c—The result of this relaxation after twelve days can be seen. Note the complete relaxation of the scar bridge, the relief of tension and the satisfactory utilization of scar infiltrated flaps.

the first metacarpal. C. N. Dowd in 1927 published an article on the use of the Z-incision in the repair of cicatricial contractures of the neck. Babcock in 1928 illustrates nicely the use of the Z-type incision in what he describes as Pieri's operation for the relief of a web between the thumb and forefinger.

It is probable that the Z-type incision has been described in other articles which we have not mentioned, but there is no question but that it was used over seventy years ago, and that it has been frequently rediscovered and described as a new procedure.

*Technic*—It is with those contractures which present a prominent bridge or web with which we most frequently have to deal, but the method is also very effective in dealing with the type of contracted scar whose contracted portion sinks into a groove and has a deep attachment instead of projecting as a bridge or web. This latter type of contracture is, of course, much less commonly found.

## RELAXATION OF SCAR CONTRACTURES

I usually choose a general anæsthetic, selected to suit the individual case but if local anæsthesia is preferred for any reason, nerve block should be used, as infiltration of scar tissue is inadvisable on account of its precarious blood supply. The technic, which is quite simple, is as follows. Prepare the area to be relaxed by the method in which you have confidence. Mark out the proposed incision carefully with 5 per cent brilliant green in alcohol on the contracted area, when the scar is under tension. The longest line of the Z is laid along the most prominent portion of the bridge or web, and the arms of the Z are marked out on opposite sides of the central line, making the pattern a Z or reversed Z depending on the condition of the surrounding tissues. The arms begin at each end of the central line on opposite sides and



FIG 4a

FIG 4b

Illustrating the use of the Z type incision for the relief of scar contractures of the fingers.

FIG 4a—Shows the hand of a child with contraction of the index, middle and ring fingers following a severe rope burn. The middle finger was so badly burned that new tissue had to be supplied after straightening the finger by means of a measured whole thickness graft. The ring and index fingers were not grafted but were relaxed by Z type incisions.

FIG 4b—Result five months later. Note that the result following the Z type incisions is as satisfactory as that following the whole thickness graft. All the fingers can be extended and function is fully restored.

are carried outward and downward, or outward and upward, as the case may be, as far as seems necessary usually ending at about the level of the middle of the central line. The incisions are then made following the pattern, and the two flaps thus formed are undercut and mobilized and are transposed, the tip of one flap being sutured into the angle found at the outer end of the "arm" incision forming the other flap, and vice versa. The irregular wound is then closed with horsehair sutures, and is dressed with a single thickness of gauze impregnated with 3 per cent xeroform ointment over which is placed a moist sterile seasponge applied under even pressure, and secured with adhesive plaster and a bandage. Finally the part is immobilized. When dealing with a grooved scar, the same procedure is carried

out except that the long line of the Z splits the groove lengthwise and the flaps are formed just as when a bridle is present

*Comments*—The treatment of burns and other extensive surface lesions which frequently result in contractures will not be considered except to say that every effort should be made to induce rapid healing with the part in proper position, as in this way excessive scar formation and subsequent contractures may be minimized. Some contractures may be avoided by very careful treatment of the original lesion, but my experience has been that contractures may and will occur in spite of every precaution. These con-



FIG 5a



FIG 5b

Illustrating the relaxation of a scar involving the axilla and trunk by the Z type incision

FIG 5a—Burn scar of many years duration. Several operations had been done previously. Note the condition in the axillary space and the dense scar extending from the axilla to the pelvic brim.

FIG 5b—Result after two months. Note the release and smoothing out of the axilla in spite of the fact that the tips of both flaps sloughed. Also note the relaxation of the entire scar on the trunk by the Z incision which now allows much greater freedom of motion. These flaps were composed entirely of thick scar tissue and it can be seen that they survived throughout.

tractures are found most frequently in the axilla, where the extremities join the trunk, around joints and on the neck and face.

As a general rule, it is advisable to delay operative work on contracted scars until nature, assisted by massage and passive motion, has had time to do all that she can. A few months will make a great deal of difference in the condition of the scar and of the surrounding tissues and by making haste slowly useless operations may be avoided, so that when we finally come to operate we will be able to see the scar as it eventually will be and can take steps to properly correct it.

This brings up the importance of the age of the patient with a scar contracture. During the growing period scar contracture, if not relieved, may materially interfere with the growth of the bony structure as well as of the

## RELAXATION OF SCAR CONTRACTURES

adjacent soft parts and may cause changes and deformities, which can never be completely remedied. However, if the contracture is relieved, say six months after healing is complete, which gives time for preliminary massage and other therapeutic measures, bone and soft part changes usually readjust themselves. In adults, on the other hand, while the question of interference with bone growth does not have to be considered, we must bear in mind the atrophy of disuse and in cases of long standing care must be taken not to cause fracture when manipulating a part, such as the arm, after relaxation. It has been my experience also that it is better not to operate on an adult



FIG 6a

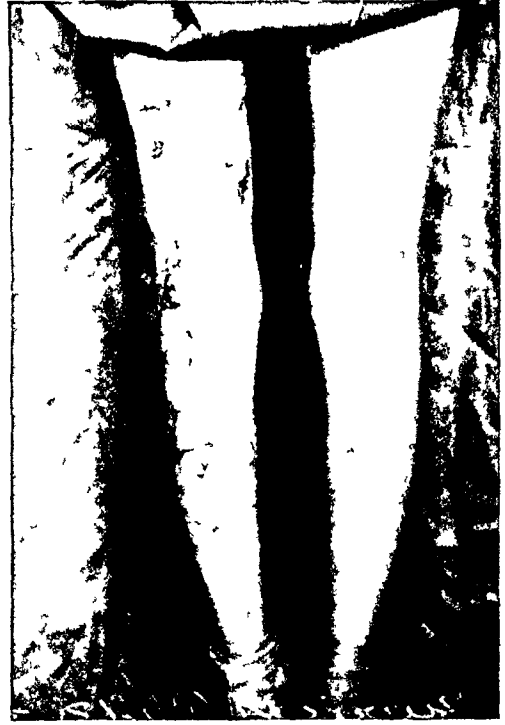


FIG 6b

Illustrating the use of several Z type incisions for the relief of a long scar contracture

FIG 6a—Burn scar contracture of the thigh and leg. Duration, seventeen years. Note the thickened bridle in the popliteal space which has never healed. Also the extent of the scar on the thigh and leg. The patient is unable to fully extend the leg, and has the sensation of tightness and constant drawing. She tires easily and has considerable loss of function.

FIG 6b—Result two months later. The ulcerated portion of the scar in the popliteal space was excised and the edges were drawn together with temporary sutures. Then the Z was marked out, the incisions made and the flaps transposed. Three other Z incisions were made in different portions of the scar and good relaxation was obtained. The patient can now walk without discomfort and has entirely lost the sensation of tightness on the back of the leg and thigh. It may be necessary subsequently to relax the depressed scar on the inner side of the thigh.

until six months have elapsed after healing is complete, in order to take advantage of improved conditions made possible by massage and stretching.

In many cases the flaps available are made up entirely of scar tissue. Only occasionally do we find a bridle or web with even comparatively normal skin running up to the contracted band, and in these instances the circulation of the flaps is naturally much more satisfactory. The ideal condition, of course, would be to break the scar pull with flaps of normal tissue.

If the scar bridle is fairly thin and soft it is split its full length into two leaves, which are utilized as part of the flaps. If on the other hand the scar



Illustrating the use of the Z type incision for the relief of scar contractures in the axilla cubital space and at the wrist

FIG 7a—Scar contracture following a burn. Note the involvement which extends from the chest to the hand. Some operative work had been done elsewhere before the patient came under my care

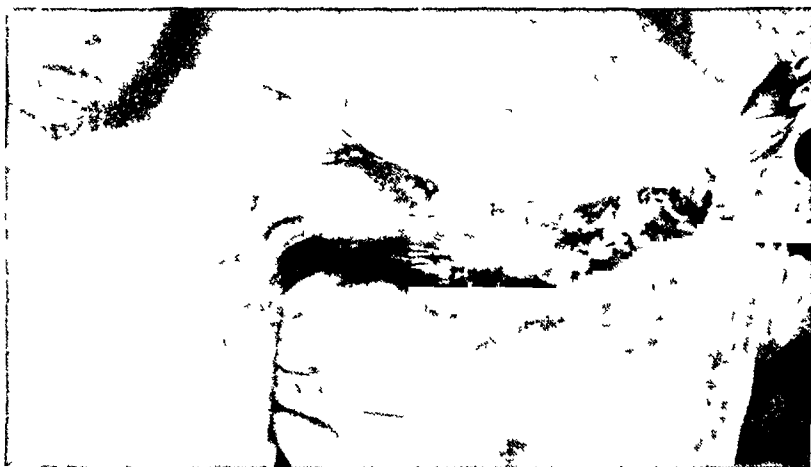


FIG 7b—Result after two weeks, of relaxation at the wrist and in the cubital space

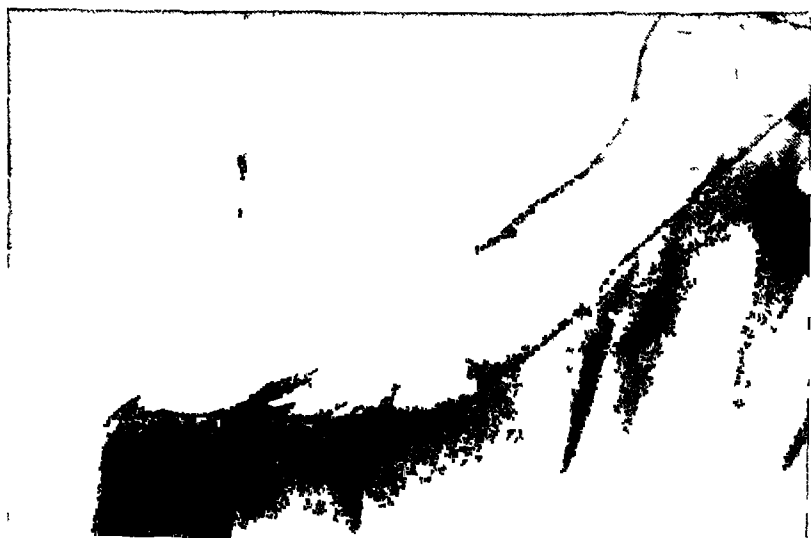


FIG 7c—The same arm after two years. During the interval further relaxation had been done on the axilla. Note the improvement in extension at the elbow and wrist

## RELAXATION OF SCAR CONTRACTURES

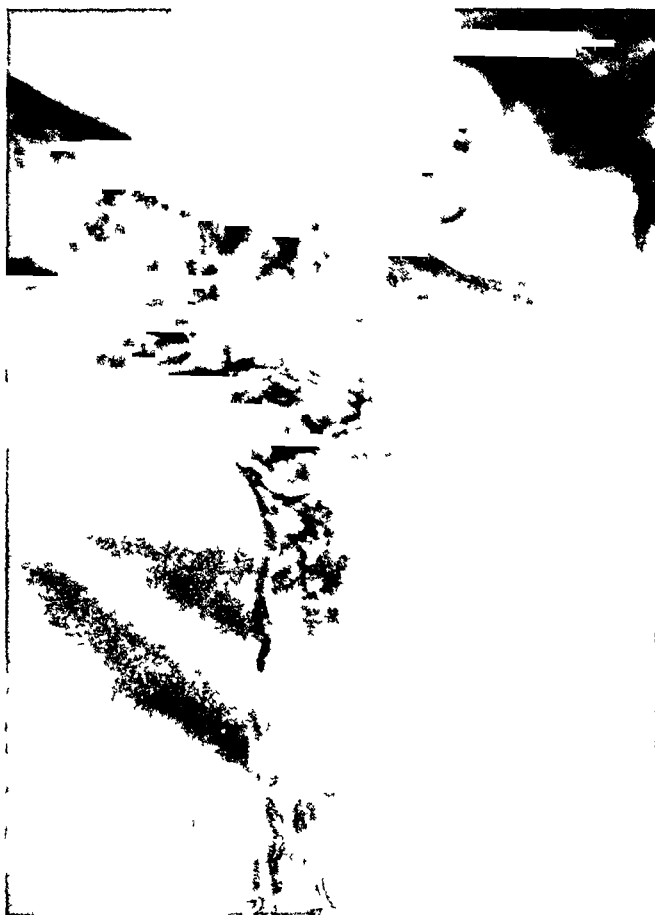


FIG 7d

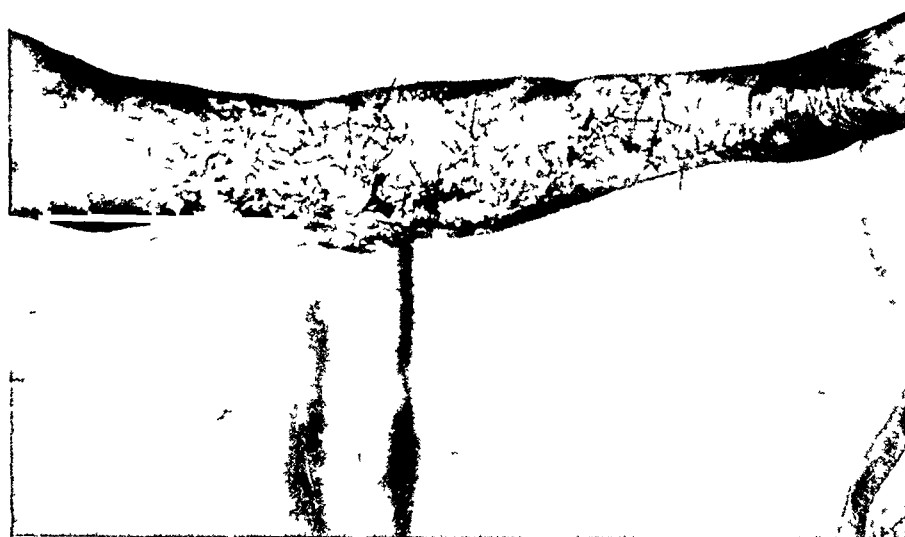


FIG 7e

FIGS 7d and 7e—One week later the final contracture in the axilla was relaxed by a Z incision which can be seen with the stitches in place. The wrist and cubital space were also relaxed by Z type incisions made in scar partially relaxed by similar incisions done two years previously. Note that full extension is now possible and that an excellent axilla has been formed.





FIG 8a



FIG 8b

Illustrating the Z type incision used several times in the same area for relaxing scar contraction  
FIGS 8a and 8b—Extensive very thick burn scar of neck chest and axilla Note the extent and character of the scar



FIG 8c—Result after eight months of the first use of the Z type incision on neck and axilla Note the difference in the character of the bridge and how much thinner and less dense it is The Z type incision was again used on the neck and in the axilla

# RELAXATION OF SCAR CONTRACTURES



FIG 8d—Result of the second use of the Z type incision after ten months. The major portion of the neck bridle and axillary web have been relaxed.



FIG 8e—The remaining contracture of neck and axilla relaxed by Z incisions used for the third time in the same areas. Note the modified Z closure with the stitches still in place.



FIG 8f



FIG 8g

FIGS 8f and 8g—Result after one month. Note the restoration of the neck and axilla.

bridle is thick and hard and is unpromising for use, then an elongated ellipse of tissue including this portion is excised and the edges are brought together with a few temporary sutures. The Z or reversed Z is then marked out, the incisions are made and the flaps are raised and transposed in the usual way.

The lines marking out the prospective flaps may vary considerably in shape and direction according to the pull of the contracture and the type of the surrounding tissue, and in this way many modifications of the Z-incision may occur. In planning flaps care must be taken to utilize the best available tissue and for this reason the incision may be a Z or reversed Z depending on whether there is less infiltration with scar to the right or to the left of the line of contracture and above or below a transverse mark dividing this line. In other words, if the tissue is less infiltrated with scar in the upper left quadrant and in the lower right quadrant (facing the patient), then the Z is used and vice versa. The contraction pull of the scar on the two sides of a central bridle may be quite different and consequently after the flaps have been formed and undercut, they may be drawn entirely away from the anticipated position. In these instances, readjustments by properly placed secondary incisions may be necessary and must be carried out before the desired relaxation can be obtained and the wound closed.

In a wide scar bridle, relaxation may be secured in more than one place, or in more than one direction by the use of the Z-incisions. In long contractures, say from the buttock to the ankle, I have used three or four of these relaxations at one operation, before the contracture was completely relieved. This was possible as there was sufficient tissue between the selected areas to prevent interference with the circulation of the flaps already made and transposed.

Should scar bands be found deep in the tissues after raising the flaps, they should be either divided or better still removed, and all tension relieved before the flaps are transposed and sutured. The flaps should be handled with small sharp dural hooks to avoid bruising. The sutures should be of horse-hair threaded on fine half-curved needles and only enough should be put in to approximate the edges. All tension on the flap should be avoided.

The tips of the flaps should be made blunt instead of pointed, as when thus made they are much less liable to slough. Even if the tips of the flaps do slough, which sometimes happens when there is much scar, we often find that sufficient relaxation has been accomplished and that soon the defect left by the sloughing tips will be filled up and the scar will become smooth again. It is advisable to have the flap as thick as may be, including some subcutaneous fat if it is present, in order to conserve the circulation. Should the tips of the flaps become bluish after a few hours of the sponge pressure, it is advantageous to apply continuous compresses saturated with normal salt or boracic-acid solution.

I have used the Z-incision for the relief of tension in fairly broad tight scars with considerable success. In the relief of congenital webbing of the neck, the Z-incision with the transposition of flaps is the method of choice.

It is also most useful in deepening the commissures in incomplete syndactylism with a wide web

When the Z-incision is used on the wrist, the flaps must necessarily be fairly short and it is better to relax at two different points rather than to attempt the formation of flaps which are too long. This may also be said of flaps about the fingers. The relaxation of a scar web, or of a congenital shortening of the web between the thumb and forefinger can often be easily relieved by a Z-incision with the transposition of flaps.

The Z-incision can be used for the relief of long contractures such as those in the axilla, and also very satisfactorily in short ones, such as we often find around the nose and ears. This gives an idea of the flexibility of the method.

In marked contractures of long standing with shortening of the underlying tissues, as much as possible should be gained at the first operation with the Z-type incision and subsequently the same procedure may be carried out in the same area after the deeper tissues have had time to stretch and soften. The character of the scar itself often changes materially, for the better, after relaxation.

The Z-type incision may also be used most advantageously in shifting the position of tissue which may be out of line. For example, where an eyebrow has been torn in an accident and two sections have healed on different levels so that one is considerably higher on the forehead than the other, by means of a properly placed Z-type incision with the transposition of flaps, the normal position can be restored quite satisfactorily.

#### CONCLUSIONS

As we use the Z-type incision the scar is not removed but the contraction is relieved by the transposition of flaps which are usually composed of scar or scar-infiltrated tissue, in such a way as to break the line of scar pull. The suture line after transposition of the flaps is, in a general way, the reverse of the original incision. It is difficult to realize how much permanent relaxation can be secured by the use of scar-infiltrated tissue and this type of incision, until one is familiar with the procedure and its possibilities. The method has simplified the handling of many cases which would otherwise have had to undergo a much more extensive and serious operative procedure in order to obtain relief.

The Z-type incision has been of great use to me when dealing with contractures in all parts of the body. I have utilized it in a large series of cases and consider it one of the most generally useful manoeuvres in my armamentarium.

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# GENERAL SURGICAL CONTRIBUTIONS

NOT PRESENTED BEFORE THE AMERICAN SURGICAL ASSOCIATION

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## AVERTIN ANÆSTHESIA\*

FROM THE ANÆSTHETIST'S STANDPOINT A RÉSUMÉ OF EIGHTEEN MONTHS' EXPERIENCE

BY JOSEPH KREISELMAN, M D  
OF WASHINGTON, D C

PRESENT-DAY surgery requires a variety of anæsthetic agents. The desirability of general anæsthesia by rectal administration in certain surgical procedures and in the presence of certain types of pathology is quite evident.

In 1926, Willstater and Duisberg were successful in the development of the drug tribromomethylalcohol, also known as avertin.

*Description*—Avertin is a white crystalline substance, easily soluble in water at 40° up to 3½ per cent. Its molecule is very labile, breaking down when heated above 45° with the formation of hydrobromic acid and dibromacetaldehyde. The latter substance is injurious to the intestines.

*Administration*—The evening before operation a cleansing enema is given. Special measures to empty the intestines on the day of operation are to be avoided, as the fluid which may remain in the bowel may retard absorption. Before the operation morphine is given as in preparation for general anæsthesia. The measured amount of avertin is dissolved in a sufficient quantity of distilled water at 35° to 40° to make a 2½ or 3 per cent solution. After being tested with a few drops of congo red (add 5 cubic centimetres of the solution to a few drops of congo red, resulting color should be a clear orange-red) the solution is injected into the rectum one-half hour before operation.

The tube is removed and the patient is allowed to remain undisturbed until asleep. If a minor operation is to be performed, no other anæsthetic is given unless it is found necessary. If the operation is to be a major one, supplemental anæsthesia is now given.

*Dosage*—Our dosage has varied from 60 milligrams to 120 milligrams per kilogram of body weight. One hundred milligrams per kilogram should not often be exceeded. In estimating the dosage, the weight of the individual is taken as a basic index, and the dosage is then varied according to the experience of the anæsthetist. A mechanical measuring of the dosage according to the body weight should not be done. It has been found that children and young adults require larger doses than the other types. The obese, debilitated, and aged require less. Those with impaired elimination require much less than the average.

No effort is made to produce complete anæsthesia with avertin alone. It is

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\*Read before the Philadelphia Academy of Surgery, May 4, 1931.

used as a basis on which deeper anæsthesia may be produced with the gases or ether. This has been called basal anæsthesia.

*Absorption and Elimination*—Avertin is absorbed by the intestinal mucosa more rapidly than is the water in which it is dissolved. The absorption is fairly rapid, 80 per cent in the first twenty minutes and 95 per cent within the first two hours.

If unduly deep anæsthesia occurs within the first twenty minutes, the rectum should be evacuated by washing with water. This not only rids the bowel of the avertin solution, but also dilutes it and delays absorption of that which remains.

Detoxification occurs by combining with glycuronic acid in the liver and it is eliminated in this manner almost entirely by the kidneys.

Adrenalin and salt solutions are effective in combating marked falls in blood pressure. Carbon-dioxide-oxygen mixtures may be used in stimulating respiration.

*Action*—There is apparently no local action. Sleep comes on gradually without excitement in from ten to thirty minutes. There is no recollection of induction. The ocular reflexes disappear, and with the average dosage the pupils are contracted and react to light.

*Duration of Anæsthesia*—In most cases the patient sleeps soundly for approximately two hours after induction. For the next three to four hours the sleep is light and intermittent. Nursing care is important at this time in maintaining a clear airway.

The respiratory rate is increased and the depth decreased.

The pulse rate approaches the normal. There is usually a fall in the blood pressure. There have been four cases with marked falls in blood pressure without apparent shock.

It appears that avertin acts in a different manner upon the brain than the anæsthetics in common use. In cases in which major surgery was performed and in which no general anæsthesia was necessary, it appeared that impulses reached the brain. This was made evident by perspiration, with change of temperature of the skin, an increase in the pulse rate, and a fall in blood pressure.

However, in these cases, there was also satisfactory relaxation.

In minor procedures, these symptoms were not apparent. Because of these untoward effects, it is a better procedure to combine avertin with ethylene-oxygen or nitrous-oxygen, or ether. These combinations afford satisfactory anæsthesias of moderate depth.

No adaptive response is excited by the anæsthetic. There is a minimum of disturbance to the sensory mechanism and mentality, hence there is a minimum of shock.

It is impossible to estimate the amount of damage done by the psychic shock produced in some patients, particularly in children, immediately preceding and during induction of anæsthesia.

Anæsthesia in pediatric surgery has always been difficult. It has been

almost impossible to do major surgery with gas. The pre-operative preparation is unsatisfactory. Because of the variable and very often untoward results with morphine, it has become routine not to use it in small children.

We then have the picture of a small child either poorly or entirely unprepared for operation. Good preparation is even more essential here than it is in the adult. The element of fear is great when the child is forcibly held and made to take an anæsthetic.

Avertin has filled the great void in pediatric surgery. A child may now be given a small enema in bed and in a few minutes he has fallen asleep without excitement and without being aware of the impending operation. The patient is returned to bed where most of the day is lost in sleep. The post-operative convalescence is not attended by the usual unpleasant post-anæsthetic upsets.

*Utility*—Avertin is particularly suitable in operations upon the larynx, cauterization of the tongue, intra-nasal operations, in moving patients with multiple fractures, in thyroid surgery, where a prolonged period of post-anæsthetic rest is wanted, when it is necessary to operate during acute alcoholism, in children, and when a general anæsthetic is distasteful to the patient.

*Contra-indications*—1 Diseases of the liver and kidneys. 2 Advanced tuberculosis. 3 Extreme cachexia. 4 Acidosis. 5 Use with care when the elimination is delayed and in dehydrated and debilitated elderly patients, and in the obese. 6 Ulcerative diseases of rectum or colon.

## SUMMARY

The early reports in the German literature show many cases of intestinal irritation. There were many asphyxias and several deaths. The dosage was too high, the solutions were overheated, and there were no trained anæsthetists to evaluate the dosage and attend the patients.

We have used avertin in 1,500 cases. The dosage has been conservative, no effort being made to produce complete anæsthesia with avertin alone, this being deemed an unwise and dangerous procedure. There have been no unpleasant complications. The method of induction spares the patient some pre-operative apprehension. It requires an experienced anæsthetist to control the superimposed anæsthesia. More time is required. Accuracy in preparation of the solution is essential. It is not a routine procedure. The nursing care is an important factor (clear airway).

It is felt that with the anæsthetic agents now at hand, avertin has a definite place.



## AVERTIN ANÆSTHESIA\*

FROM THE SURGICAL STANDPOINT A RÉSUMÉ OF EIGHTEEN MONTHS'  
EXPERIENCE

BY CHARLES S. WHITE, M.D.

OF WASHINGTON, D. C.

THE evolution of the administration of ether, from the paper cone and simple can, to the present day battery of tanks and valves, has taken place in a comparatively few years. The search for the ideal and universal anæsthetic, like the brook, goes on, and has brought to light several new and valuable agents, each with some particular virtue and some particular sin.

In the following recitation of our personal experience with avertin, we shall not enter into a discussion of the relative merits of the various anæsthetic agents, as it would open a controversial subject. Each surgeon regards his favorite anæsthetic very much in the same way that the indulgent parent regards his child, and no good could possibly be accomplished by a comparative analysis.

Our experience with avertin began in August, 1929. Our first patient was a muscular negro who was given the German dose, that is, the dose recommended in the German Clinics in 1927 and 1928. The promptness with which the patient went to sleep, and the depth of anæsthesia which followed, convinced us that avertin at least had possibilities.

We secured the help of two veterinarians and at their hospital had them do a few operations and readily found the surgical and lethal dose of the drug in dogs. From that time we felt that we had a fair estimate of the maximum dose and it was not long before we had a working formula which we still use, although it is not as accurate as we would desire. We have used avertin in more than one thousand cases and still continue to use it routinely.

Doctor Kreiselman has discussed avertin from the anæsthetist's standpoint, and we shall stress the clinical manifestations, rather than the administration and physiologic actions. The induction has been uniformly quiet, and nothing approaching a mania has been seen in a single case. Occasionally, the patient becomes loquacious and hilarious but never combative, and sleep follows within ten minutes.

In a few medical students one of our friends timed them for loss of memory after the introduction of avertin, and it was found that consciousness was lost after three minutes, although several of them spoke intelligently for two or three minutes longer. It may be a peculiar trait of medical students to be intelligent when they are apparently unconscious. My experience has been just the opposite.

In about 2 per cent of the cases, the patients reacted excitedly, just as we

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\*Read before the Philadelphia Academy of Surgery, May 4, 1931.

occasionally meet after ether, but this is decidedly the exception to the rule. In our total number of cases, restraint has been necessary only two or three times. The patient becomes coherent in from two to three hours after administration of the anæsthetic, then falls into a semi-conscious state for an hour or two longer, during which time he will be responsive to ordinary conversation. From this period his convalescence is not noteworthy.

In no case do we depend exclusively upon avertin, but a supplemental anæsthetic is always employed. The induction of the anæsthetic state is prompt and comfortable and, in this respect, it is not approached by any other agent with which we are familiar.

The relaxation during avertin anæsthesia, with the dosage we employ, is often sufficient for minor manipulations, or operations, but not sufficient to proceed with an abdominal exploration, and for that reason we use a supplemental anæsthesia—ethylene, nitrous oxide, or novocaine. In a difficult case, it may be necessary to add a small amount of ether at the time that the greatest possible relaxation is necessary, but this is not done routinely. With the larger dose of avertin, complete relaxation can be secured, but we believe that the patient takes an unnecessary risk, and the practice is to be discouraged.

We have not had circulatory or respiratory failure in any case during an operation, nor have we lost a case subsequent to operation, from any cause, that could be attributed to the anæsthetic. On several occasions, the respiration became very shallow, during the administration of ethylene or nitrous oxide, but the use of carbon dioxide and oxygen allowed us to proceed in every instance. In brief, we have had no accidents, not even an explosion of ethylene.

We have had our post-operative trials and tribulations and have worried about vomiting and distention, just as we have always done and just as we always expect to do. It is a mistake, we believe, to attribute the vomiting after operations to the anæsthetic, particularly after abdominal operations. No one doubts but that any anæsthetic, improperly administered, may be the source of vomiting, but in many instances, particularly in persistent and protracted vomiting, we should look for obstruction, peritonitis, acidosis, or alkalosis. We feel that the anæsthetic is stressed unduly as the cause of vomiting. However we found that 22 per cent of our cases had post-operative nausea or vomiting and this is less than one-half the percentage we found with ether.

We have not observed that distention was any more or any less after avertin than any other general anæsthetic, and the same statement holds good regarding retention of urine. Here, too, we believe that the anæsthetic has a good alibi.

The remote complications are always of much interest and importance, particularly in reference to the lungs and kidneys.

Naturally, we avoid any general anæsthetic in any known acute pulmonary disease, but the unfortunate fact remains that some subacute condition may be present and not detected prior to the operation. With a better understanding of lung complications, for which we are largely indebted to Dr. Walter

E Lee, the so-called ether pneumonia has been replaced by atelectasis, or collapse, and just what part the anæsthetic plays in this, we confess our ignorance. Our experience leads us to say that collapse of the lung has been more frequent after spinal anæsthesia, than any other, but our cases have been too meagre to be of any real value in estimating the relative frequency. We have had post-operative elevation of temperature, cough and expectoration of various degrees of severity after avertin anæsthesia. These cases were not X-rayed before and after operation and, in most instances, the diagnoses were not conclusive. The roentgenologist and internist have not completely agreed and it is impossible to state the relative frequency of lung complications following avertin. One thing is certain, the incidence has not increased. Some of the cases were a concern for merely a day and four were quite ill, but no mortality followed from that cause. We feel that this question is still debatable and considerable research is necessary before the relation of the anæsthetic to pulmonary collapse can be rationally discussed.

We have not hesitated to use avertin in cases of chronic pulmonary tuberculosis and have seen no ill effects.

As avertin is not a renal irritant, we should expect no untoward effects after its use in a patient with normal kidneys, as we estimate normal kidneys by urinalyses. Our experience bears this out. We have not found any serious aggravation of a mild nephritis after its use, if we believe that a trace of albumin and a few casts are indicative of kidney disease. With a seriously impaired renal function we question the propriety of any general anæsthetic.

As the liver bears the brunt of avertin disintegration, it is the organ that should suffer most following the administration of this anæsthetic. This is probably true, but has not been brought home to us by actual experience. The liver will meet the demands of the body when the entire organ is almost replaced by a neoplasm. It seems endowed with a superhuman metabolic mechanism. It stands abuse almost as well as the stomach, and it is for that reason, perhaps, that we have failed to notice toxicity of hepatic origin after the use of avertin. In one instance we put it to a test. A patient with advanced carcinoma of the liver had a strangulated hæmorrhoid and we elected to relieve him under avertin anæsthesia. His expectancy of life was very brief and we are sure that both the patient and the family would have been grateful for an earlier end. The anæsthetic put him to sleep promptly and the operation was satisfactorily done. The atypical aftermath was the delirium, which lasted three days.

There are said to be two contra-indications to the use of avertin. Serious impairment of liver function and ulceration of the rectum. It is apparent why it should not be used in a case of damaged liver, and it is not used in an ulcerated bowel, because it will not be absorbed promptly, even if it is retained. These contra-indications should be accepted until confirmed or disproved by further use of the drug.

# AVERTIN ANÆSTHESIA

## SUMMARY

Avertin offers a safe, comfortable, and speedy approach to the full state of anæsthesia, provided the dose does not exceed 100 milligrams per kilo of body weight, and is given by a competent anæsthetist. We desire to particularly stress first the smaller dosage, as compared with the German formula, secondly, an anæsthetist must have charge of the anæsthetic. Supplemental anæsthesia with novocaine, ethylene, nitrous oxide, or even ether is recommended. We know that many will offer the objection that two anæsthetic agents complicate the administration. We believe that the comfort the patient enjoys and the fear from which he is relieved, are well worth the additional effort and time on the part of the anæsthetist. No better proof is necessary than the statements of the patients who have had both types of anæsthesia. We even have anæsthetists in Washington who would take avertin by choice, and no greater thing could be said of any anæsthetic. We believe the professional anæsthetist is just as essential to the perfect operation as the surgeon's assistant, the pathologist, or any other member of the hospital staff.

The contra-indications to the use of avertin at the present time are serious impairment of liver function and ulceration of the rectum.

Doubtless some may ask themselves: Why a new anæsthetic, with the number of anæsthetic agents in use today? We would answer that question much as Faraday answered a similar question many years ago. After he had read before a distinguished audience, a paper on electro-magnetism, someone asked him "What is the use of all these new ideas?" Faraday replied "What is the use of a new-born babe?"

THE RESULTS OF AVERTIN BASIS ANÆSTHESIAS, WITH ETHER,  
NITROUS OXYGEN AND ETHYLENE—BASED ON  
CLINICAL AND METABOLIC STUDIES—REPORT  
OF 700 CASES

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THE standard for any kind of anæsthesia used in surgery should provide, as far as possible, for the safe exclusion of pain and psychic disturbance of the patient in order to make the operation a success

The following paper has to deal with 700 cases of avertin anæsthesias with the idea of ascertaining how far we are able to fulfill these postulations

Out of 1,750 operations in one year, 700 operations were carried out under avertin anæsthesia. Hence, it is clear that not all cases are adaptable to avertin and that the principal indication for every anæsthesia has to be made for each patient individually. In other words, the surgeon has to decide for every single case which form of anæsthesia is best adapted to each patient. Therefore, it is necessary to bear in mind the general condition of the patient, heart and lungs and state of shock, *etc*. If the circulatory system is weak, then avertin anæsthesia is contra-indicated. Furthermore, in our hospital, complete avertin anæsthesia without supplementary measures is not used. By the results and experiences of the German authors there is shown that doses of avertin, needed for a complete anæsthesia without supplement, are too large and too toxic so that it is not advisable to force a complete avertin narcosis (Rehn and Killian<sup>27</sup>). Such a complete narcosis with the toxic, non-controllable avertin does not correspond with the biologic laws of the organism, particularly not with those of the diseased organism.

Here, therefore, we are dealing only with the avertin "basis narcosis" (Straub<sup>30</sup>) and its combination with ether, nitrous oxygen ( $N_2O$ ) and ethylene ( $C_2H_4$ ), the latter two being combined with oxygen.

First, there is a brief note necessary as to the principal fundamentals of the supplements used in order to compare their effect and biologic reaction in combination with avertin.

*Ether*.—Ether acts as a stimulant to blood-pressure, especially at the beginning of its administration, while avertin has a tendency to decrease the pressure. Blalock and Franken<sup>12</sup> have called attention to the increased heart effort due to a specific heart reaction caused by the ether. By increasing or decreasing the ether blood concentration, one can readily control and regulate the respiration, and hereby accomplish an individual deep or light anæsthesia. Anschuetz<sup>3</sup> states that there is a "favorable influence of ether on blood-pressure and respiration, when avertin is combined with small amounts of ether," and it doubtless compensates in part for the severe drop of blood-pressure, which is as a rule the case after using avertin.

*Nitrous Oxide with Oxygen* ( $\text{N}_2\text{O} + \text{O}_2$ ) —The circulatory system is not unfavorably influenced, the blood-pressure does not drop and there is no inconvenience to the respiratory centre.  $\text{N}_2\text{O}$  does not influence the metabolism to any greater extent, for instance, there is no increase in lactic-acid content in the blood, or no regular prolonged increase of blood-sugar content. The disadvantage of a relatively light anæsthesia when used alone becomes an advantage in the combination with the strong narcotic effect of avertin, as it is compensated in so far as small doses of avertin are used (Domanig,<sup>30</sup> Floerchen<sup>31</sup>)

*Ethylene* ( $\text{C}_2\text{H}_4$ ) —No disadvantage has been found in the use of nitrous oxide as well as ethylene on the circulatory or respiratory system. There has been noted during the course of ethylene administration an elevation in blood-pressure, which is particularly desirable in view of the undesirable effect of avertin. No severe hyperglycæmia, no diminishing of the  $\text{CO}_2$  combining power, or only a small decrease of alkali reserve is found after ethylene, its narcotic effect being stronger than that of nitrous oxide and its very quick deprivation of the lungs corresponding to the sudden awakening of the patient. Luckhardt and Carter<sup>32</sup> (1923) and Luckhardt and Dean Lewis<sup>33</sup> (1923) employed ethylene for the first time as an anæsthetic on humans. The latter authors note 700 ethylene anæsthesias on an experimental basis and favorable clinical results. According to them a concentration of 80 to 90 per cent, ethylene to 20 to 10 per cent oxygen is necessary for a complete ethylene anæsthesia. Dean Lewis has resected the stomach, using ethylene for the anæsthesia without any complications (J. A. M. A., vol. LVII, p. 1854, 1923). The above-mentioned concentrations are given for a complete ethylene anæsthesia. In our experiments with numerous combinations of avertin ethylene narcosis we find that these smaller concentrations often give good results. A certain advantage of ethylene is the better peristalsis of bowels in the post-operative condition, so that the post-operative pains, as well as the distention by gas, and also the danger of post-operative ileus is diminished (Dean Lewis). Contrary to ether there is no increased mucous secretion, so bronchitis and bronchopneumonia are rare.

*Disadvantages of Ethylene* —(1) Bad odor, which, nevertheless, is noticed only a very short time before the quick narcotic effect. (2) Slight increased bleeding from the wound. (3) The danger of explosion, which can be avoided or diminished by pure ethylene free from carbon-monoxide, making it necessary to avoid the dangers of this highly inflammable gas via fulguration, open lights, lighting cigarettes, etc. We may perhaps state that it would be inadvisable to put the ethylene tank near the operating table, but as near the operating room as possible, keeping in mind that this necessitates a longer length of tube from the machine to the patient, which is a disadvantage, but acts as a safeguard as far as an explosion is concerned.

*Technic of Avertin Anæsthesia* —Pre-operative treatment. Morphine 12 milligrams. Atropin 0.6 milligram. The avertin solution is prepared every morning, separately for each case and prior to each operation. The average dose is usually 90 milligrams per kilo. Smaller doses of 80 to 85 milligrams per kilo, particularly for smaller operations and for weak, cachectic patients, are often used. In cases with a poor general condition and in children, even smaller doses of 60 to 70 milligrams per kilo are used, in strong men 90 to 95 milligrams per kilo is the limit. A 3 per cent avertin solution is used and it is necessary to have a regular control of avertin solution by Congo red.

According to our clinical experiences and to the proposals of Rehn and Killian, etc., only avertin basis narcosis should be carried out as a rule. With the use of this anæsthesia, there is an apparent deep sleep with relative relaxation but accompanied by a positive feeling of pain. Ether, nitrous

oxide or ethylene is used as a supplement before operation. If, in a single case, the supplement with  $N_2O$  is not sufficient, then one can change or combine  $N_2O$  with ether, which is easily done by the use of the Foregger or McKesson machine. In such a way one can control and steer the avertin basis narcosis with a larger or smaller amount of ether or gas supplement. This clinical statement is founded on the pharmacologic investigation of Straub,<sup>30</sup> Lendle<sup>18</sup> and also on the clinical reports of White,<sup>33</sup> Parsons,<sup>25</sup> Lundy,<sup>24</sup> Guttman,<sup>13</sup> Speidel<sup>29</sup> and others.

In 700 such cases avertin basis narcosis was employed and combined with ether or gas without fatality and with very satisfactory results. There is a definite blood-pressure effect with avertin (an average drop of 30 to 40 milligrams mercury). Immediately after the ether effect and likewise after gas, a certain rise of blood-pressure is always the case. The blood-pressure curve shows better results after these mixed anaesthesias than after a complete avertin anaesthesia. In some cases, ephedrine was given with the avertin enema to prevent the drop of blood-pressure, as ephedrine is absorbed by the mucous membrane, with and sometimes without results. We should, nevertheless, bear in mind that after other anaesthesia methods, a drop of blood-pressure is known to occur, for instance, after spinal anaesthesia (Pitkin) and after caudal anaesthesia (Widenhorn<sup>34</sup>).

Then, too, we must not neglect the fact that independent of the anaesthesia, a decrease of blood-pressure may result from the operation itself (pulling the peritoneum or the splanchnic nerve or the pedicle of the kidney, *etc.*).

The pulse shows generally a reasonable elevation and remains at this level and rises on the average of 100 to 110 pulsations a minute. Ether and gas have an increasing influence.

The respiration during this combined method is essentially more favorable than after complete anaesthesia. The statement of Puckner's<sup>26</sup> "Avertin depresses the respiratory centre, lessening both frequency and volume," is correct for the complete avertin anaesthesia. In the majority of our cases, our protocols of the frequency and breathing per minute are the same in the beginning, during and at the end of the anaesthesia, usually 20 to 22 respirations per minute.

During each of the 700 anaesthesias the blood-pressure, pulse, and respiration were measured at intervals of five minutes.

The amount of the supplementary anaesthetic depends on the following: (1) On the amount of the single dose (milligram avertin per kilo). (2) On the amount of the whole dose (cubic centimetre per patient). (3) On the type of operation. (4) On the time of operation. (5) On the individuality of the patient, as every patient requires an individual amount of avertin as well as of ether and gas.

Furthermore, the post-operative sleeping time after these anaesthesias was studied. One can differentiate between a first and a second sleeping time. The first one is counted until the patient first awakes, when the patient first reacts, responds and is able to speak. The second sleeping time includes

the secondary phase of relaxation, which is incomparable to the deep sleep noted after complete avertin anæsthesia. After small doses of avertin anæsthesia the first sleeping time is remarkably short, often the patient awakes immediately after operation. If  $\text{N}_2\text{O}$  or  $\text{C}_2\text{H}_4$  is used with avertin, the short period of the first and second sleeping time is apparent.

The best adaptations for the use of avertin and ether are laparotomies, resections of intestines, cholecystectomies, exophthalmic goitre, strong persons, men rather than women.

The best uses for avertin and gas are thoracic operations, the extremities, breast operations, anæmic and cachectic patients, women rather than men, age rather than youth.

Besides these clinical investigations we have carried out some metabolic studies and would like to give a few examples. With numerous patients the  $\text{CO}_2$  combining power and blood sugar at certain intervals were determined, in order to learn how great and how lasting was the effect of the anæsthesia. The alkali reserve ( $\text{CO}_2$  combining power) was determined after the method of Van Slyke, the blood sugar after Benedict. We know the very important influence of anæsthetics on these factors alone. Crile and Menten<sup>9</sup> (1915) found in dogs and rabbits an increase of PH-concentration after ether, chloroform and nitrous oxygen. Caldwell and Cleveland<sup>7</sup> and Austin<sup>5</sup> found a decrease of alkali reserve after ether. Carter<sup>8</sup> and Morris discuss the decrease of plasma bicarbonate in dogs after ether. Atkinson and Ets,<sup>4</sup> as well as Van Slyke, Austin and Cullen<sup>32</sup> have noted the decrease of  $\text{CO}_2$ -combining power of the blood, similarly reported but differently explained by Henderson and Haggard<sup>14</sup> (1918).

In regard to these changes, after complete avertin anæsthesia as studied by Achelis,<sup>1</sup> Wymer<sup>35</sup> and by Bruger, Wesley Burne and Dreyer<sup>6</sup> (McGill University) the latter authors have reported their experiment on dogs, and I would like to report my investigations on humans, since these results after avertin basis anæsthesia combined with small doses of ether or with  $\text{N}_2\text{O}$  or  $\text{C}_2\text{H}_4$  are not known.

$\text{CO}_2$  combining power and blood sugar was determined before, immediately after operation, and eight and twenty-four hours after operation to ascertain the intensity and duration of the influence of this particular anæsthesia on the metabolism of the body. In order to give the exact data concerning the quantity of avertin and ether, the type and time of operation, the table of measurements is included here.

The following was observed. After avertin and ether, the  $\text{CO}_2$  combining power does not drop so low as it does after complete avertin narcosis. It drops slightly, improves after eight hours, and remains at the normal rate in twenty-four hours.

After avertin and ether the blood sugar, as after many anæsthesias, increases, nevertheless, it does not rise so highly as it does after complete avertin anæsthesia (see table). The normal rate usually occurs after eight hours, and regularly after twenty-four hours.



CO Combining Power Blood Sugar in Mgrs Per Cent

Sex	Age	Diagnosis	Operation	Time of Operation in Minutes	Avertin in Cc	Ether in Cc	8 Hrs				24 Hrs			
							Before Opera- tion	After Opera- tion	After Opera- tion	Before Opera- tion	8 Hrs After Opera- tion	24 Hrs After Opera- tion	8 Hrs After Opera- tion	24 Hrs After Opera- tion
F	29	Hernia abdominal wall	Laparotomy	90	5 85	57	53 2	49 4	46 6	49 4	95	120	125	75
M	15	Fibrosarcoma of thigh	Amputa femur, remov glands Bassini	120	3 5	120	58 9	48 5	51 3	54 1	95	148	125	110
F	24	Ing hernia	Bassini	60	7 0	150	59 5	51 9	50 4	61 3	86	130	90	95
M	58	Carc lip, metas glands	Fxision, plastic, remv glands Bassini	150	5 4	120	50 4	59 4	50 4	53 2				
M	45	Ing hernia, biat- eral	Bassini	150	5 4	200	64 5	50 4	58 9		90	155	105	
M	57	Carc ear, metas glands	Excis plastic, remv glands	180	6 4	150	55	54 1	55 7	63 0				
F	34	Exop goitre	Part lobect	90	5 3	150	48 5	38 1	49 4	44 7	72	100	75	110
F	44	Exop Goitre	Doub par lobect	120	4 3	180	54 8	50 0	51 9	54 8	100	140	124	105
M	35	Ing hernia, bilateral	Bassini, bilateral	150	5 0	180	55 0	54 1	49 4	53 2				
Gas Nitrous Oxide Ethylene														
F	54	Adenoma of thyroid	Extirpation of adenoma	60	6 6	N <sub>2</sub> O	54 8	55 7	51 3	52 2	110	125	116	110
F	29	Pyosalpinx, append- chron	Laparotomy, appen- dectomy, ovaric- tomy	150	4 3	N <sub>2</sub> O	59 5	56 7	59 5	50 5	105	152	155	115
F	54	Carc breast	Rad operation	150	4 9	N <sub>2</sub> O	61 7	57 9	51 3		60	96	100	
F	63	Cholelthasis ulcers stomach	Cholecystectomy, gastroenterostomy	160	4 6	N <sub>2</sub> O	53 2	43 8	47 5	49 4	60	148	140	135
M	51	Exoph Goitre	Double partial lo- bectomy	120	4 9	C <sub>2</sub> H <sub>4</sub>	52 8	51 0	51 0	51 8	100	120	145	115
F	41	Fibroma of breast	Amputa of breast	75	4 3	C <sub>2</sub> H <sub>4</sub>	53	57 0	59 8	58 9	100	115	130	105

Avertin and  $N_2O$  shows a still better picture as far as  $CO_2$  combining power and blood sugar is concerned. There is a little drop of  $CO_2$  combining power. Very often the rate remains within normal limits, and even immediately after operation it is rarely below 50.

The hyperglycæmia is of small amount and short duration. A few instances of avertin ethylene give a favorable view of the influence of this combined avertin gas method. There is no particular remarkable decrease of  $CO_2$  combining power. We consider, therefore, the combination of avertin and gas  $N_2O$  as well as  $C_2H_4$  as very efficient. The  $CO_2$  and blood-sugar determinations indicate very satisfactory clinical results.

## CONCLUSIONS

In one year, 700 operations were carried out under a combined method of small avertin doses with supplements of ether, nitrous oxide and ethylene (so-called avertin basis narcosis) without any fatalities. Complete avertin anæsthesia is not recommended. The usual avertin dose is from 60 to 95 milligrams per kilo.

If in any instance the  $N_2O$  is insufficient as a supplement for relaxation, it is supported by ether at the same time. Ether and gas act as a stimulant. Ethylene can be used in small concentrations (50-50 or 70-30).

The advantages of these combinations are that there is less toxicity with small avertin doses and stimulation of the respiratory and circulatory system is accomplished by the use of small amounts of ether or gas, which shortens the post-operative sleeping time.

Blood-pressure, pulse and respiration were measured every five minutes, and showed a more marked improvement after this combination had been used than after the complete avertin anæsthesia.

Investigations of  $CO_2$  combining power and blood sugar before and after operation show a relatively slight decrease of  $CO_2$  and a slight increase of short duration of the blood sugar. This method is advised as satisfactory on the basis of 700 anæsthesias given without complications.

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# A STUDY OF SPINAL ANALGESIA BASED UPON 357 PERSONAL CASES

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SPINAL analgesia has never been favored with universal acceptance. Neither can it be truly said that the method has received steadily increasing endorsement. To reach its present status, which is apparently somewhat favorable, the method has been subjected to intervals of commendation and condemnation. It is now a routine method with many surgeons and is frequently employed by many others. That it cannot be used as a universal anæsthetic is readily granted, but through development of factors of safety, it has been accepted as the procedure of choice in many conditions and is generally conceded to be a necessary addition to the anæsthetic methods of every surgeon or anæsthetist. Spinal analgesia has passed the experimental stage and now stands as a reliable and satisfactory method of analgesia which cannot be excelled within the scope of its indications. As it is, a special technical method, spinal analgesia has never proved safe for routine use, but if employed skillfully, the mortality and morbidity compare very favorably with other types of anæsthesia.

*History*—After Corning<sup>1</sup> of New York unintentionally used spinal analgesia, he suggested its surgical applicability in 1894, and four years later Bier<sup>2</sup> of Kiel proved its feasibility, and endorsed it for surgical use. The next report of the use of spinal analgesia in America was made by Matas<sup>3</sup> in December, 1899, in which he told of injecting a 1 per cent solution of cocaine into the spinal canal between the fourth and fifth lumbar vertebræ and obtained analgesia sufficient to perform a hæmorrhoidectomy. Tait and Caglieri<sup>4</sup> are credited with having performed an ostectomy of the tibia under spinal analgesia on October 26, 1899, but their work was not reported until April, 1900. The method soon became popular especially in America. In France, Tuffier,<sup>5</sup> was responsible for bringing the procedure into prominence. With the wide acceptance of the method came a number of variations of a technic that at best was poorly understood. In 1900 Morton<sup>6</sup> used a spinal injection of cocaine to produce general anæsthesia sufficient for operations on any part of the body. Eight years later this same method was popularized by Jonnesco.<sup>7</sup> Spinal analgesia, and unfortunately very frequently spinal "anæsthesia," was heralded with such wide acclaim that very early the disastrous results outweighed the favorable ones. Only cocaine was available, the technic at best was crude, and there can be no wonder that the method was soon unpopular. Bier, its original endorser, was as definite as anyone in denouncing indiscriminate use of spinal analgesia and, as is still true today, this exemplifies the fact that those who know most

about the method are most critical as to the indications for its employment. These early bad results are even now a basis for much skepticism and still somewhat overshadow the increasingly good results. In 1904 stovaine was introduced and was soon popularized, especially by Babcock<sup>8</sup> in America. His results were remarkably better than any previously obtained, but were still not all that could be wished. His recent good results have, however, become outstanding. During the past few years renewed interest in spinal analgesia has been manifested, no doubt due in a large part to the commendable work of Pitkin,<sup>9</sup> and to the availability of ephedrine with which to prevent alarming lowering of the blood pressure. With the present wave of enthusiasm has come the usual number of rediscoveries of variations of technic and application of spinal analgesia. Koster<sup>10</sup> has enthusiastically revived the procedure which in 1910 Jonnesco<sup>7</sup> said was "a new one and altogether distinctive, because I have generalized spinal anæsthesia, adopting it to all operations on any part of the body."

*Advantages*—The surgeon who has used spinal analgesia is always reluctant to dispense with it. The advantages are manifold. Granting that the prime requisite of all anæsthetics is safety, spinal analgesia can be made safe and therefore allow the patient and the surgeon to be benefited by its advantages. Pre-operatively, patients need not be denied fluids unless the type of operation contra-indicates it. Effective prophylaxis of acidosis can, therefore, easily be continued uninterrupted. In emergency operations not infrequently the pre-operative treatment must of necessity be reduced to a minimum. Spinal analgesia will often prove to be a choice method under these circumstances.

Some patients are distressed by the anticipation of loss of consciousness and are particularly grateful for some anæsthetic method other than general anæsthesia. The patient who has on different occasions had inhalation anæsthesia and spinal analgesia expresses a most critical opinion. It is significant that such a patient almost invariably elects spinal analgesia when a third operation must be performed. The surgeon who is accustomed to operating upon patients under inhalation anæsthesia is particularly impressed with the surprising ease with which he can accomplish most of the steps of the operation when using spinal analgesia. Relaxation is more complete than can be obtained even by deep ether narcosis. Retraction of an abdominal incision is hardly necessary. The intestines are contracted and fall away from the abdominal wall so completely that gauze packs are rarely needed even for operations requiring wide exposure of the operative field. Respiration is quiet, and unaccompanied by coughing or straining, thereby allowing the surgeon to work unhampered by extraneous movements. Operative procedures are facilitated and trauma is minimized. Very soon after operation the patient can be allowed to take fluids. Nausea or vomiting is infrequent. Post-operative distention is not unusual after inhalation anæsthesia and is always an annoying and frequently a disastrous complication if it occurs. Distention is rarely observed after spinal analgesia. Peristalsis is augmented

by the uninhibited impulses from the vagus nerves, and after cessation of analgesia normal peristalsis is quickly reestablished and meteorism prevented. Urinary retention is no more frequent than after other types of anaesthesia. The incidence and seriousness of post-operative pulmonary complications are possibly reduced. Spinal analgesia has been definitely proved to have no deleterious effect on the normal heart, kidneys, or liver, and even when these organs are diseased, spinal analgesia is well tolerated.

*Disadvantages*—The science of surgery knows but few ideal procedures. Spinal analgesia would be unique if it had no disadvantages. The method is highly technical, but is simple enough to be mastered by those who are willing to devote sufficient time to its study. It offers to the surgeon a method of analgesia over which he has direct supervision and its efficacy parallels the surgeon's technical efficiency in its use. Alarming lowering of the blood pressure has formerly been a classical untoward reaction. Appropriate doses of ephedrine given before induction of spinal analgesia usually prevent this condition. If reduction of the blood pressure should occur, it is temporary and its onset is within a few minutes after the induction of analgesia and is well tolerated because the patient has not been subjected to operative shock.

Spinal analgesia should not be used for operations above the diaphragm, or at least to do so is dangerous and subjects the patient to unnecessary risk. There is no difficulty in establishing analgesia to a higher level—even of the scalp, indeed great care must be taken in order to prevent a maximum diffusion of the anaesthetic agent. Regional limitation of the analgesia, therefore, narrows the scope of the applicability of spinal analgesia. The length of the analgesic period when novocaine is used is one and one-half hours or two hours. The dose can be safely increased to produce analgesia for two hours in nearly every instance. It seems that all, except very unusual abdominal operations, should be completed within this time. If the operation must, for some reason, be prolonged beyond this time, other forms of anaesthesia must be resorted to or a second spinal injection may be given.

Trauma is an accompanying factor when, for any reason, a spinal puncture is done. Likewise, the possibility of introducing organisms is always present. Aseptic technic should prevent the latter and if small caliber, blunt beveled needles are skillfully used, the factors of trauma should be negligible. Certainly more spinal punctures are being done as diagnostic and therapeutic procedures than for the purpose of inducing spinal analgesia. They all carry the same possible dangers, but little has been said to discourage employing spinal puncture for diagnosis. Headache has occurred with sufficient frequency to warrant consideration. Its causes are clearly understood at this time and definite, efficient preventive methods are now commonly employed. Vomiting may occur, but when marked, is usually evidence of high diffusion of the analgesic drug and should not accompany properly controlled spinal analgesia. The peculiar phenomenon of temporary paralysis of the abducens nerve has been reported, especially by the earlier observers. This has

not been observed recently as new, less toxic drugs have been more carefully employed

*Contra-indications*—Spinal analgesia can be safely employed routinely to produce analgesia below the diaphragm with few, yet very definite, exceptions. The margin of safety is never great, and to disregard contra-indications is to invite disaster. Patients must be selected for spinal analgesia only after careful individual consideration. A careful history must be taken and a thorough examination made to elicit and evaluate factors which might contra-indicate spinal analgesia. Anæsthesia for imperative operations is often a difficult problem. Shock is frequently present, and the risk is great regardless of all precautions. The uninitiated may feel that in a "bad risk" case spinal analgesia is the method of choice. Any patient in shock tolerates spinal analgesia poorly and in such cases with acute shock or hæmorrhage spinal analgesia should not be administered. Such patients would, however, tolerate inhalation anæsthesia equally as poorly, and if some operative intervention is imperative, it could be more safely performed with local or regional analgesia. Indeed there are few indications for operations being done in the presence of shock. If the shock is relieved, spinal analgesia may safely be employed.

Patients with hypotension have previously been considered unsuited for spinal analgesia. This is generally true only if the hypotension is "acute" as from shock or hæmorrhage, which has been mentioned previously. With appropriate doses of ephedrine hypotension should not prove an absolute contra-indication. The author has repeatedly employed spinal analgesia successfully in patients whose systolic blood pressure was less than 100 millimetres of mercury.

Extreme cardiac decompensation and decreased vital capacity contra-indicate inhalation anæsthesia as well as spinal analgesia. The surgeon must, therefore, use local analgesia if operative procedures are imperative. Acute central nervous system disease, brain or spinal cord tumor, or neurosyphilis are reasons for not using spinal analgesia. Septicæmia is a contra-indication to spinal puncture and localized abscesses or ulcers at the site of puncture obviously prevent the introduction of a spinal needle.

All of the contra-indications cannot be considered here, but if spinal analgesia is to be employed successfully, contra-indications cannot be too carefully and honestly weighed in each individual case.

*Indications*—As is true in other surgical procedures, the individual's adeptness is an important factor in answering the question as to when spinal analgesia should be used. Surely those who use spinal analgesia frequently have safely widened its field of application, and perhaps there should be less criticism of this extended scope of indications when thus used with expert efficiency. Spinal analgesia has met its severest trials because so many surgeons have reserved it for use in "bad risk" cases. The elderly, emaciated patient has been the characteristic type for which spinal analgesia has been

used Stanton,<sup>11</sup> in 1927, sent a questionnaire to 1,000 surgeons. Of the 622 answering the question "Do you use spinal anæsthesia, if so, in what class of case do you use it?" 419 stated definitely that they did not use spinal analgesia, and of those who used it, 90 per cent stated definitely that they used it only in special types of "bad risk" cases. It seems logical to remark in this connection that the type of anæsthetic which is safest for the "bad risk" is just as safe for the "good risk" cases. Although spinal analgesia has had to survive the test of being used on patients who were admittedly poor anæsthetic risks, it is now well known that, although spinal analgesia can be used under these circumstances, its greatest scope of usefulness does not lie within this field.

In the presence of marked arteriosclerosis spinal analgesia may not be used to good advantage, but not infrequently conditions associated with the arteriosclerosis make other forms of anæsthesia still more definitely contra-indicated. Nephritis and cardiac disease are frequently present and arterial hypertension is the rule. Such patients are far from ideal subjects for spinal analgesia but tolerate spinal analgesia as well as any other of the usual forms of anæsthesia. Some have thought that since lowering of the blood pressure frequently accompanies spinal analgesia that patients with arterial hypertension would be well suited for spinal analgesia. It cannot be stated too emphatically that this is not true. A sudden lowering of the blood pressure is even more disastrous to these patients than a similar decrease of blood pressure would be to the normal individual. Fleming and Naffziger<sup>12</sup> have called attention to the frequency of coma, hemiplegia, and other symptoms, usually attributed to apoplexy, which occur in individuals with extreme hypertension and are not due to the rupture of a cerebral vessel, but are due to cerebral anæmia resulting from a sudden decrease in blood pressure. Although spinal analgesia is not contra-indicated by hypertension *per se* it should be used with extreme caution in the presence of very high blood pressure. Marked fluctuation of the blood pressure is disastrous. Ephedrine must be used very cautiously if it is employed at all. An increase of the blood pressure may cause apoplexy and a decrease may cause fatal cerebral anæmia.

It has been repeatedly shown that spinal analgesia does not injure the parenchymatous organs, and therefore it will prove to be the anæsthetic method of choice in patients with definite renal disease. The diabetic patient tolerates spinal analgesia better than most forms of inhalation anæsthesia. Acute pulmonary disease is a classical contra-indication to inhalation anæsthesia. It cannot be definitely said that the instance of pulmonary complications is remarkably decreased following spinal analgesia. Most surgeons are reluctant, however, to use inhalation anæsthetics in the presence of respiratory disease. Spinal analgesia will prove most valuable in patients with intestinal obstruction. Not only does spinal analgesia serve as a valuable therapeutic agent by blocking the splanchnic nerves, but it is also an invaluable aid to the surgeon because relaxation is so perfect and the intestine



so contracted that the operation can be speedily performed with a minimum amount of trauma

Spinal analgesia is of value in obstetrics. The author has had occasion to use this form of anæsthesia in several cases and has been impressed by the favorable results. A special technic must be employed, however, and a report of these cases will be made later. In this series, the only use in obstetrics recorded is that of cæsarean section.

*Accompanying Phenomena*—Spinal analgesia is induced by introducing the drug into the spinal fluid which bathes the intradural tissues and hence brings the anæsthetic solution into direct contact with the nerve roots. The

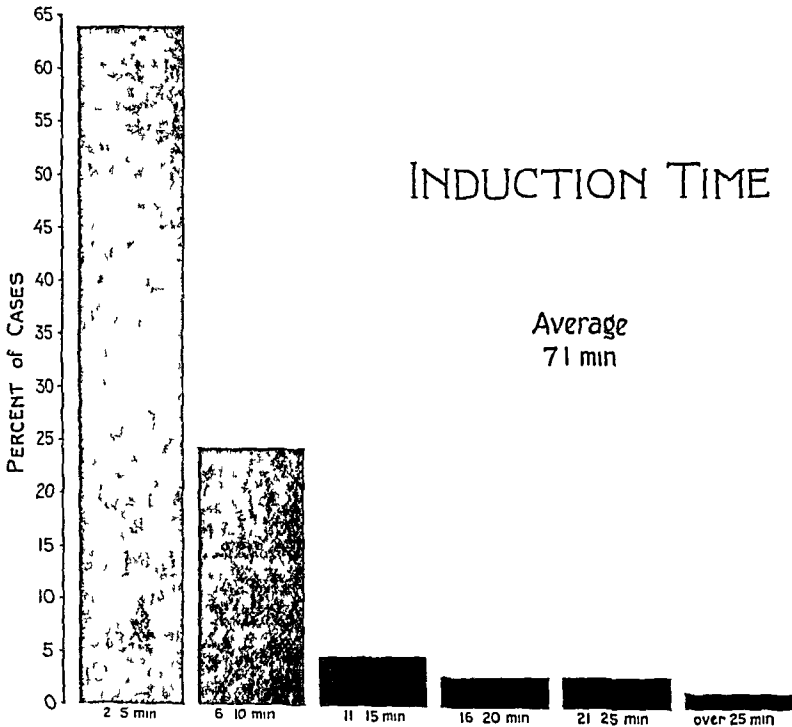


CHART I—As is shown by the blocks, almost 90 per cent of the spinal analgesias were induced within ten minutes. The small per cent requiring a longer period of time represent those cases in which a second injection was necessary.

drug is quickly absorbed by the nerve roots both in the spinal canal and for about two centimetres beyond their exit. Analgesia cannot be established gradually by slowly administering the drug, but occurs at once from a single injection and cannot be diminished. Also, if analgesia is insufficient, it cannot be increased except by a second injection. The cord itself is probably not very deeply penetrated by the analgesic drug. If the analgesic agent is held in a restricted area, the nerves thus bathed by the concentrated solution will be permeated quickly and diffusion will be prevented. If wide diffusion occurs, the drug will be most effective at the point of injection, but at no point will there be deep penetration of the roots, and the duration of analgesia will be expectedly less or may be insufficient. If a large dose of such

a diffusible drug is given in order to insure sufficient blocking of the nerve roots, distressing and dangerous symptoms will occur from such an extensive analgesia

The first nerve roots to be affected are the sensory fibres. Their position favors ready contact with the injected analgesic drug and these fibres are less resistant to the penetration of the drug. Loss of sensation, therefore, is noted first and is most complete and lasting. The motor roots are less susceptible but are next blocked, although not completely, unless certain drugs are used which have a special affinity for the anterior roots. The sympathetic nerve fibres whose function is vasomotor control are last affected. In an ideal spinal analgesia the sensory nerve roots would be blocked, but conduction would be uninterrupted in the motor roots. These anterior or motor roots from the second thoracic to the first lumbar segment contain the white rami communicantes, and therefore an analgesic involving this section would cause paresis of the sympathetic system in direct ratio to the number of anterior nerve roots involved. When such an involvement is extensive, cardiac, vasomotor, and respiratory depression results. A blocking of all the motor and sensory roots to the level of the first thoracic segment results in a maximum decrease of the blood pressure. To extend the analgesia to the level of the fourth cervical segment is to block the phrenic nerves, and diaphragmatic paralysis then results. As the accessory muscles are paralyzed before the diaphragm, if phrenic nerve anæsthesia occurs, we are then confronted with a very critical situation—respiratory failure. It is, therefore, apparent that the ideal spinal analgesia should involve as few motor roots as possible and certainly there should be no analgesia to a level higher than is indicated for infra-diaphragmatic operations. Sufficient loss of sensation to permit operations about the head does not indicate a high motor anæsthesia but simply indicates its possible concomitant occurrence. Loss of sensation frequently occurs without motor paralysis, but it surely seems unwise to attempt to obtain loss of sensation at levels so high that if concomitant motor paralysis should occur the results would be disastrous. Undoubtedly, when diffusible analgesic drugs are used, some degree of blocking almost uniformly extends to a high level. It is fortunate, however, that in diffusing, the solution becomes so dilute that complete motor anæsthesia does not occur in the upper segments.

The vagus nerve has an extensive distribution in the thorax and abdomen. Its action directly opposes the sympathetics. Spinal analgesia does not, of course, affect the vagus nerve, but on the contrary removes the inhibiting force of the sympathetics and allows the vagus nerve to exhibit unrestrictedly a depressor action in the thorax and a motor accelerator action in the abdomen. The cardiac and respiratory rates are slow. The splanchnic vessels dilate, peristalsis is augmented, and the intestines are contracted.

The dose of the drug injected is always small in so far as systemic toxicity is concerned. Babcock<sup>8</sup> has said that "In no other way can so extensive an analgesia be produced with so small a dose of a drug." The

toxicity is therefore of secondary importance to the more critical question of diffusion of the drug in the cerebrospinal fluid. Lowering of the blood pressure occurs in almost exact proportion to the height of the spinal analgesia. In order to facilitate operations in the upper abdomen, it is necessary to produce an intraspinal block to the level of the seventh thoracic segment. No severe and uncontrollable vascular or respiratory symptoms should result from such a procedure, and appropriate doses of ephedrine given prior to the induction of analgesia efficiently prevent any alarming fall of blood pressure. If analgesia is required for operations below the level of the umbilicus, analgesia of the spinal nerve roots is needed only to the level of the tenth thoracic

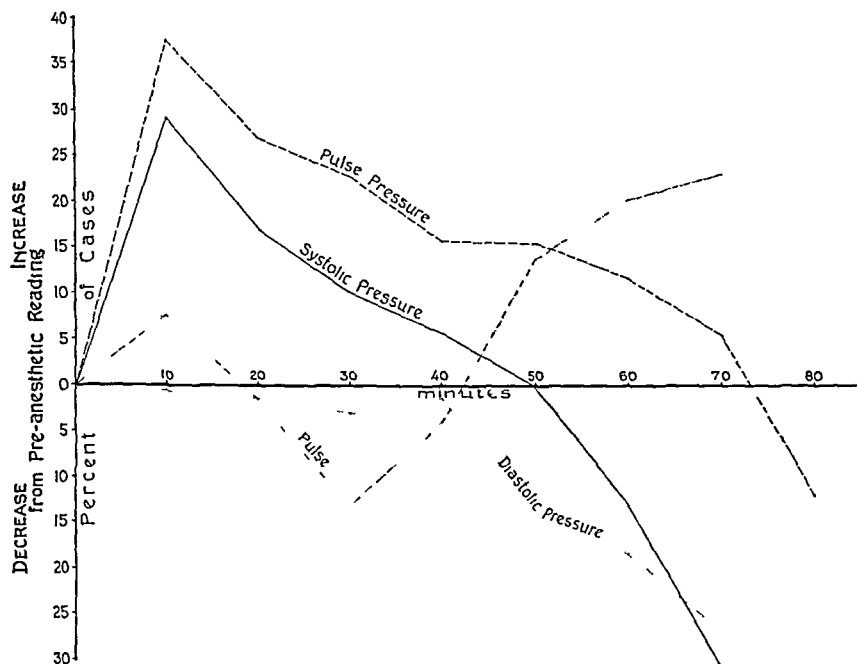


CHART II—These curves are drawn from determinations on 357 cases of spinal analgesia induced with spinocain. The curves illustrate what is known clinically *viz.*, that the systolic blood pressure is increased at the early part of the anesthesia and gradually falls as the operation progresses and shock is superimposed upon the anesthetic. At fifty minutes it is seen that the systolic pressure is decreased sharply. A decrease at this late period must be attributed to operative trauma. The diastolic pressure shows very little change until the systolic pressure drops sharply when it shows a similar drop. The pulse is slightly accelerated at first no doubt due to the use of ephedrine and then remains slow for forty five minutes and then shows a marked increase in longer operations. The pulse pressure is seen to behave very similar to the systolic blood pressure.

segment. Only a very slight degree of vasomotor depression should accompany such an analgesia. Operations below the iliac crests can be performed with analgesia to the level of the first lumbar segment, and perineal operations may be successfully done by blocking only those nerves which leave the dural sac in its caudal tip. In either instance the systemic reaction is negligible.

*Drugs and Technics Used*—The consideration of the diffusion of the analgesic drug has always been paramount. Bier recognized this fact and early experimented with cocaine, but had only mediocre success. Fourneau<sup>13</sup> discovered stovaine in 1904, and as this drug proved to be less toxic than

## SPINAL ANALGESIA

cocaine, considerable improvement in spinal analgesia immediately followed its introduction. A characteristic action of stovaine is the marked temporary motor paralysis which occurs immediately after intradural injection. This is due to the affinity of stovaine for the anterior roots. As motor root analgesia is perhaps less desirable, stovaine has not maintained its popularity, especially since the introduction of novocaine. Apotheresine has been used in a considerable number of cases of spinal analgesia, especially during the World War. Orth<sup>14</sup> reports excellent results with apotheresine and Schutz<sup>15</sup> reported its use in 2251 cases. In general, however, it has been discarded in favor of less toxic drugs. The same might also be said of tropococaine, tutocaine, butyn, and many others. Novocaine has been subjected to very critical study and is now generally recognized as the most satisfactory local analgesic. Its early use in spinal analgesia consisted in injecting the novocaine crystals put into solution by using distilled water, normal saline, or spinal fluid as a solvent. Very satisfactory results have been obtained by using accurate doses of novocaine crystals dissolved in spinal fluid. A long list of followers of this method might be named, but probably Labat's<sup>16</sup> name is more closely associated with this method than any other. At the present time this is undoubtedly the most popular technic and has given very excellent results. Stout<sup>17</sup> has recently called attention to "volume control" technic whereby controllability can be obtained. A relative degree of controllability can always be obtained by such simple considerations as regulation of dose, amount of spinal fluid used, rate and speed of injection, and site of puncture.

Outstanding objections to the use of crystalline novocaine in spinal fluid have been the short duration of analgesia and the lack of absolute controllability. Novocaine has been used in many different analgesic solutions, most of which have been intended to take advantage of a difference in specific gravity to acquire controllability. Barker,<sup>18</sup> Hepburn,<sup>19</sup> and Sise<sup>20</sup> have used a glucose solution which is heavier than spinal fluid, and have obtained satisfactory control of the diffusion to facilitate operations in the upper abdomen. The nerve roots very quickly absorb the novocaine from this solution and a change of the patient's position is made possible if such becomes necessary. In view of the fact, however, that one of the most efficient methods of combating cerebral anæmia is the placing of the patient in the Trendelenburg position, it would seem dangerous to use a solution to produce spinal analgesia at a high level which would prohibit lowering the head at any time if syncope should occur. Pitkin<sup>9</sup> has developed a viscous novocaine solution of light specific gravity in order to take advantage of the Trendelenburg position. Such a procedure is not new, but in view of the success of the method since its introduction, it would seem that the preparation is more efficient than its predecessors. The ideal spinal analgesic should be one of low toxicity and definite controllability. Pitkin's solution would seem to approach this ideal.

Novocaine is still the sheet anchor of local, regional and spinal analgesia. Although it has been mixed with many different substances, novocaine

probably works most efficiently when mixed with common sense and a thorough knowledge of the phenomena accompanying spinal analgesia

*Analysis of Cases*—The author has used crystalline novocaine dissolved in spinal fluid as has been stated, in a previous report,<sup>21</sup> and although the results were not unsatisfactory, certain undesirable features were evident. The short duration of the analgesia with novocaine crystals was a serious handicap. Control of the level of analgesia was only relative. No serious complications developed, however, and no deaths occurred. Recently, Pitkin's method has been adopted and the last 357 consecutive spinal analgesias have been induced according to his technic. There seem to be some outstanding advantages. There has been no difficulty in limiting the level of

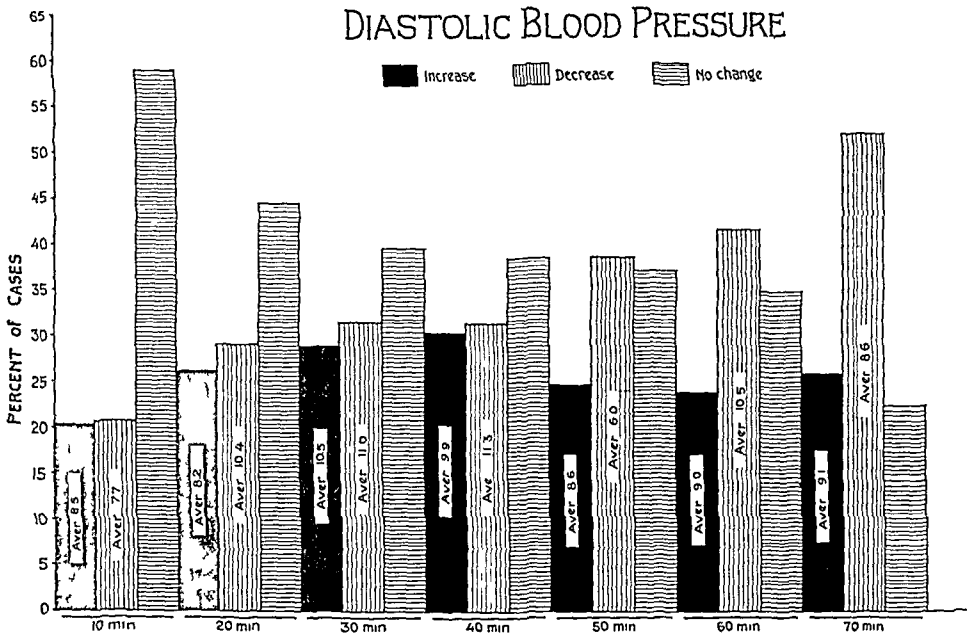


CHART III—The diastolic blood pressure is little affected early in the anesthetic as is shown by the very large percentage of cases which show no changes. This percentage decreases however so that at seventy minutes those cases showing a decrease are the largest number of cases. The figures on the blocks show the average increase or decrease in the diastolic blood pressure in millimetres of mercury.

analgesia, and the average duration of the effect of the drug is longer than was noted with novocaine crystals. It has been very unusual for analgesia to disappear in less than two hours, and in many instances operative procedures continued for two and a half hours without supplementary anaesthesia. The average length of time required for operations was forty-eight minutes. Satisfactory analgesia is always anticipated for one and a half hours, and in only a few instances has there been a shorter duration. In nine instances, operative procedures required longer than two and a half hours, inhalation anaesthesia was necessary as a supplement in three of these. In six cases, analgesia was present for less than one and a half hours and inhalation anaesthesia was necessary. The usual note on the chart indicates, however, that "gas was used while closing the incision." The higher the

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level of analgesia, the shorter the duration. Upper abdominal analgesia is expectedly maintained for a shorter period of time than analgesia of the lower extremities. Some of the longest successful analgesias were for prolonged orthopedic operations on the lower extremities. When localized perineal analgesia was obtained, it was of relatively short duration since only one-half a cubic centimetre of spinocain (fifty milligrams novocaine) was used.

In eight cases, a second injection of analgesic solution was necessary in order to establish the desired analgesia. In four others, a second injection would probably have made spinal analgesia adequate. In these four cases, the circumstances were such that second injection was not made. The usual

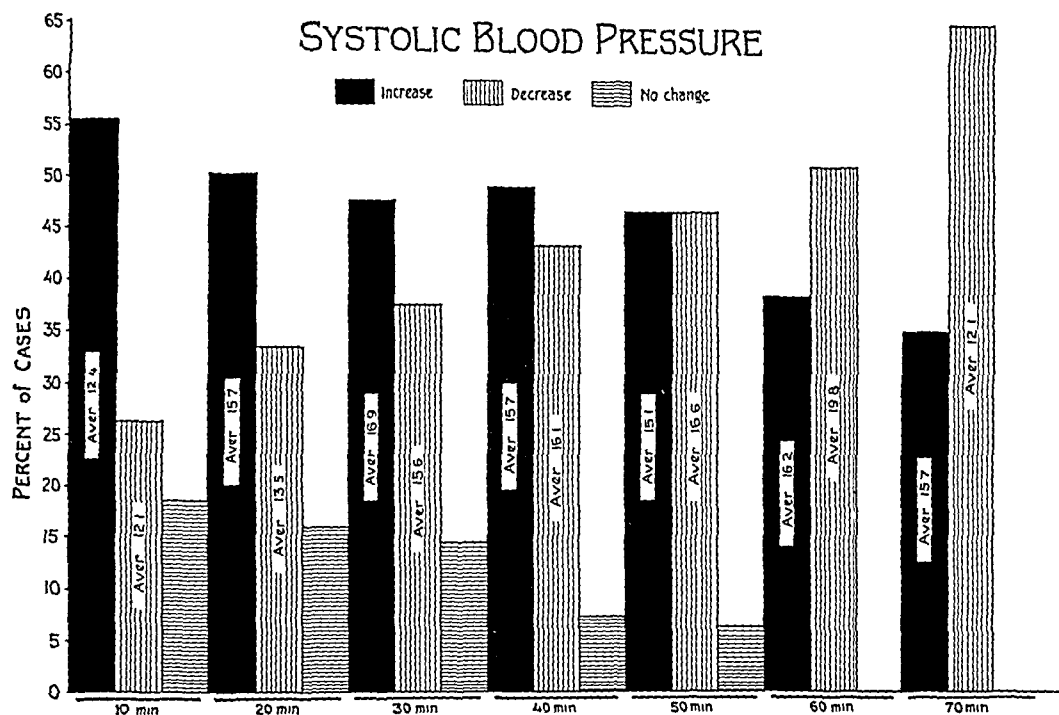


CHART IV—The large number of cases showing an increase in the first ten minutes is probably due to the action of ephedrine and also due to the fact that the anæsthetic has been established only two or three minutes. As the anæsthetic continues and the operation progresses it is well known that the systolic blood pressure decreases. At seventy minutes it is seen that those cases showing a decrease in the systolic blood pressure are nearly double those showing an increase. The figures on the blocks show the average increase or decrease in the systolic blood pressure in millimetres of mercury.

reason was that an impatient surgeon chose to proceed with local analgesia or general anæsthesia, rather than delay for a second spinal injection. Regarded in the light of success of the primary injection, all twelve of these cases can be regarded as failures. Failure is nearly always due to faulty technic, usually insufficient diffusion. There has been, therefore, no hesitancy about employing a second injection.

In one instance, satisfactory analgesia appeared twenty-five minutes after injection, but this is unusual. The average time elapsing between injection of the solution and establishment of the desired degree of analgesia was 7.1 minutes (Chart I). The doses recommended by Pitkin<sup>9</sup> have generally been used. For upper abdominal analgesia 3 cubic centimetres of spinocain have

been used routinely. In one instance 6 cubic centimetres were used, a second injection of the full dose having been made. In patients with a normal blood pressure, 50 milligrams of ephedrine was the usual dose and was given subcutaneously about five minutes prior to injection of the spinal analgesic solution. The dose of 100 milligrams of ephedrine was unusual and was given to "hypotensive" patients in whom "high" analgesia was necessary. Adrenalin has not been used in this series. In cases in which analgesia below the iliac crests was established, no ephedrine was used. In most of the patients a slight rise in the blood pressure was noted early, the blood pressure returning to normal or slightly below, as the operation progressed and the ephedrine effect became less. (Chart II.) This drop below normal does

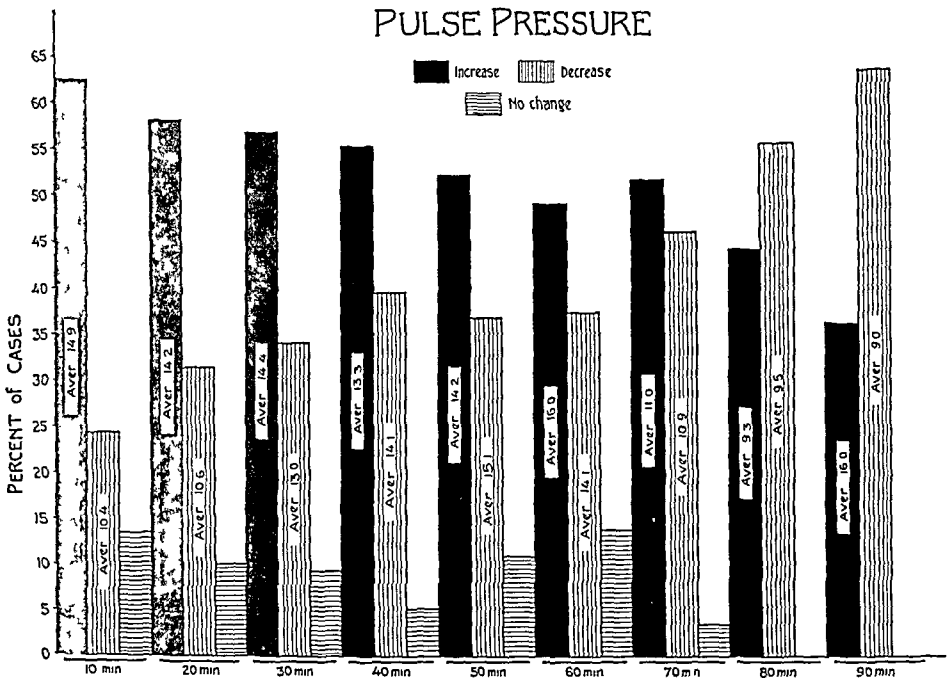


CHART V.—The pulse pressure is increased at the beginning of the anæsthetic but consistently decreases as the anæsthetic and operation progress. The average increase or decrease of the pulse pressure is shown by the figures on the blocks.

not continue unless operative shock has been marked, for with the cessation of analgesia vasomotor equilibrium is quickly reestablished. Unless prevented, the blood pressure may drop to a sufficient degree to be alarming. This has formerly been a most frequent complication. It did not occur in this series, however, except in two cases in which the cause was plainly an unusual loss of blood. In one patient undergoing caesarean section, a 46 millimetres of mercury decrease in the systolic blood pressure occurred fifty minutes after spinal injection, but during this time considerable bleeding had occurred. One patient became markedly exsanguinated from loss of blood from both uterine arteries during the course of a hysterectomy. The analgesia could hardly be blamed for the shock which occurred in this case.

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The systolic blood pressure usually showed a sharp rise during the first ten minutes after the subarachnoid injection of the analgesic solution. At the end of fifty minutes the systolic blood pressure returned to the pre-analgesic level. Any marked decrease, thereafter, can hardly be attributed to the spinal analgesia. If an operation is of long duration, some decrease in the systolic blood pressure must be expected. In those cases in which the operation was not prolonged and the patient was returned to bed, it was gratifying to see the absence of symptoms of shock. As has been said, this no doubt can be attributed to the disappearance of the primary depressive action of the spinal analgesia, which allows the patient to regain quickly a normal circulatory equilibrium. The variations of the pulse, diastolic blood

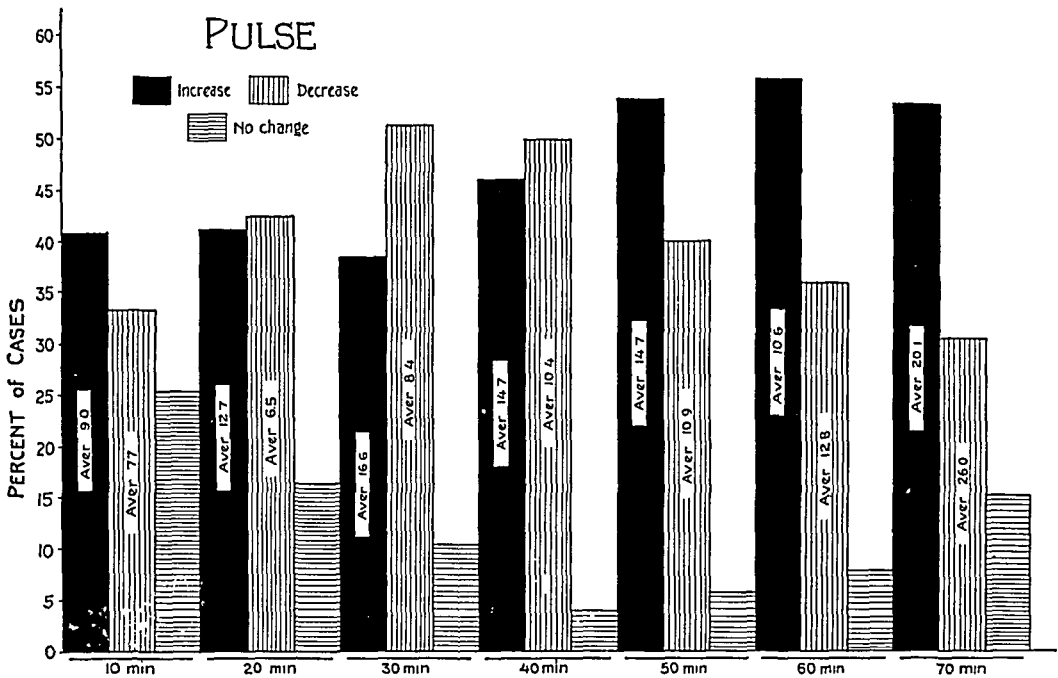


CHART VI—A decrease in pulse rate is seen in most cases at the beginning of spinal analgesia. As the operation progresses it is seen that the number showing an increased pulse rate increases or almost double those showing a decrease. The average increase and decrease in pulse rate is shown by the figures on the blocks.

pressure, pulse pressure, and systolic blood pressure, are indicated in Chart II. The diastolic blood pressure was not markedly affected. Those changes from the pre-analgesic reading which occurred were not very great (Chart III). The systolic blood pressure showed considerably more variation (Chart IV) than did the diastolic blood pressure. The pulse pressure varied in almost exactly the same manner as did the systolic blood pressure (Chart V). The pulse was decreased at the beginning of the analgesia but increased in rate as the operation progressed (Chart VI).

Post-operative urinary retention has been present in about the same number of patients as has been noted following inhalation anaesthesia. There has been no case which required repeated catheterization. Most of the patients requiring catheterization during the first twenty-four hours were those who had had perineal or rectal operations.



The possibility of headache occurring post-operatively led the author to observe a routine of prophylaxis. Twenty-two gauge Pitkin needles were used routinely and especial care was taken not to allow the patient to make the slightest movement while the needle was *in situ*. Leakage from a large needle puncture or a rent in the dura, made by the patient's movement while the needle is in place, is the most common cause of post-spinal-puncture headache. A second type is due to blood, irritant solutions, or actual infection in the spinal fluid. Following operation, the bed was placed in the Trendelenburg position for twelve hours unless contra-indicated by other conditions, such as peritonitis. In this series no patient developed headache sufficiently severe to require special treatment. None complained of this symptom and only a few indicated its presence upon being questioned. Morphine was given routinely for post-operative pain, and undoubtedly this prevented many from complaining of a mild headache.

Vomiting has not been very frequent. Oxygen inhalations gave almost instant relief to those cases which exhibited some nausea during the period of analgesia. In all, 5 per cent of the cases in this series exhibited some degree of nausea and vomiting during the analgesic period. In no case was post-operative vomiting severe.

There has been no example of ocular palsy, motor paralysis, or sphincteric incontinence. There has been no fatality which could be directly attributed to spinal analgesia.

#### SUMMARY

Three hundred and fifty-seven cases of spinal analgesia induced with spinocain are reported. Twelve failures occurred. Of these, eight obtained satisfactory analgesia after a second sub-arachnoid injection of spinocain. The remaining four received no second injection and operation was performed under inhalation anaesthesia. No deaths occurred which could in any way be directly attributed to the spinal analgesia. The length of the analgesia period was definitely more prolonged than when crystalline novocaine dissolved in spinal fluid was used. Satisfactory analgesia for one and one-half hours was obtained in nearly every case. The analgesia period was shorter when the level of analgesia was high, as for upper abdominal operations. There were two cases which showed an alarming fall in blood pressure. In both instances, however, a severe hæmorrhage had preceded the drop in blood pressure. Ephedrine was given routinely, and was apparently responsible for preventing the drop in blood pressure usually seen following the induction of spinal analgesia. Post-operative urinary retention which required repeated catheterization was not encountered in this series. Severe post-operative headaches did not occur. Nausea or vomiting occurred in 5 per cent of the cases of this series. When this complication occurred, relief could be obtained by the administration of oxygen.

An analysis of the variations of blood pressure, pulse, and pulse pressure in the cases of this series is presented. This analysis was obtained from a

study of records of these findings made every ten minutes during the period of analgesia

The results seem to indicate some advantage of spinocain over crystalline novocaine, if careful technic is observed

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## SPINAL ANÆSTHESIA

REPORT ON A SPINAL ANÆSTHESIA QUESTIONNAIRE AND A SERIES OF SPINAL ANÆSTHESIAS<sup>†</sup>

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SPINAL anæsthesia is not a new method of preparing a patient for a surgical operation, but its latest wave of popularity has assumed great proportions and is still rapidly gaining in volume. The first wave of popularity in this country came between 1912 and 1917 following Jonnesco's visit to America advocating *stovaine* as the anæsthetic, but it was rather short-lived because of the high mortality rate due to the incomplete knowledge of the physiological action of the drugs used and also because of its injudicial employment. However, Wayne Babcock, of Philadelphia, and Rudolph Matas, of New Orleans, continued to use it with excellent results. Modifications, additions, and improvements have been added to the technic and armamentarium by Labat, Pitkin, and others, and today we consider spinal as a valuable and permanent addition to our list of anæsthetics.

There are numerous drugs used as spinal anæsthetics and various media used for dissolving them, but the purpose of this paper is not to discuss them in particular, believing that one will get the best results if he will perfect his technic with one certain solution and use it routinely. The real purpose of this paper is to report in detail 220 cases of spinal anæsthesia given since May 1, 1930, and also to report the results of a questionnaire concerning spinal anæsthesia sent out to 500 surgeons practicing in twenty of the large cities geographically distributed over the whole country.

(1) Is spinal anæsthesia safe when used correctly? (2) What is its usual effect on blood-pressure, pulse and pulse-pressure, especially during the operation? (3) What are its indications and contra-indications? (4) What are its advantages to the patient and the surgeon? (5) What are the post-operative complications? These are questions we will attempt to answer, using records and graphs to illustrate.

We believe that spinal anæsthesia is safe in both high and low abdominal surgery providing the dose of the anæsthetic, the method of injection, and the handling of the patient are correct. There was no anæsthetic death in our series, and there was but one patient whose systolic blood-pressure went below 50 millimetres of mercury. This case did not constitute a scare but ordinary procedures for combating a fall in blood-pressure were instituted. We do not believe that the spinal injection should be given by one inexperienced in its use. There are various, apparently minor, details necessary

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<sup>†</sup> Read before the Minneapolis Surgical Society, May 22, 1931.

to its complete success, and one should use it only after repeated observations and then only when one experienced in its use can direct him for a time

*Age and Sex of the Patients*—Table I gives the ages of the patients in decades and the ratio of males to females in this series

The number of patients in the second, third, fourth, fifth and sixth decades were about equally divided. There were none under ten years of age. We have avoided giving it to patients under ten years, but do not believe youth to be a serious contra-indication. Cooperation is lacking in the very young, and that is a serious handicap to the surgeon. Twenty-three, or about 10 per cent, were over sixty years of age. We have not considered advanced age as a contra-indication unless the systolic blood-pressure was extremely high (240) and the accompanying diastolic pressure comparatively low, or

AGES

DECADE	NUMBER OF CASES
1 - 10 years	0
10 - 20 years	43
20 - 30 years	37
30 - 40 years	45
40 - 50 years	40
50 - 60 years	32
60 - 70 years	19
70 - 80 years	4

Males 137; Females 83. =

220 = total

TABLE I—Ages by decades and ratio of males to females

unless the patient had a decompensated heart. Extreme hypotension (below 95 systolic), especially in adults, has been considered a contra-indication.

We have tried to limit the use of spinal anaesthesia in this series, as far as possible, to patients belonging to the good risk group, regardless of age, not wishing to discredit it by a high mortality rate in patients in whom it was used where the deaths were not definitely due to the anaesthetic.

The operations in this series are indicated in Table II.

It will be noted that there were no operations above the diaphragm. It is our opinion that operations above the diaphragm contra-indicate the use of spinal anaesthesia, the danger being paralysis of the voluntary muscles of respiration, and, when the anaesthetic reaches a little higher level (fourth cervical), paralysis of the phrenic nerve and, through it, the diaphragm.

*Blood-pressure Effects*—By far the most interesting point in spinal anaesthesia is its effect on blood-pressure. The cause of the fall in pressure is unquestionably due to the paralysis of the white rami emerging from the anterior horn of the spinal cord. This paralysis results in a loss of vasomotor

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constriction in the splanchnic vessels and in a consequent accumulation of a larger volume of blood therein. This effect makes possible cerebral anæmia, hence the imperativeness of the Trendelenburg position. That the fall in pressure is greater in some than in others—all else being equal—is explained on the theory that the dentate ligament separating the anterior and posterior subarachnoid spaces is denser in some than in others, rendering the transfusion of the anæsthetic solution variable. Graphs I and II indicate the extreme variation of blood-pressures taken at five-minute intervals.

### O P E R A T I O N S

Herniotomy (all varieties)	60	Gunshot wound of abdomen	1
Appendectomy	72	Lacerations of leg	1
Cholecystectomy	14	Excision of exostoses	1
Hemorrhoidectomy	6	Incision for cellulitis	1
Gastroenterostomy	1	Vasectomy	1
Gastric resection	3	Intestinal anastomosis	2
Pyloroplasty	4	Removal of cyst	1
Salpingectomy	6	Removal of foreign body	1
Hysterectomy	5	Orchidoplasty	1
Prostatectomy	2	Bowel resection	1
Anterior colporrhaphy	1	Exploration of common duct	2
Posterior colporrhaphy and perineorrhaphy	1	Exploratory laparotomy	4
Oophorectomy	2	Anal fistula	1
Incision of pelvic abscess	2	Ventral suspension	1
Fracture (Lane plate)	2	Amputation of leg	7
Osteomyelitis	5	Hydrocele	1
Correction of hallux valgus	1	Rectal abscess	2
Curettage	1	Pilonidal cyst	2
Nephrotomy for stone	1		

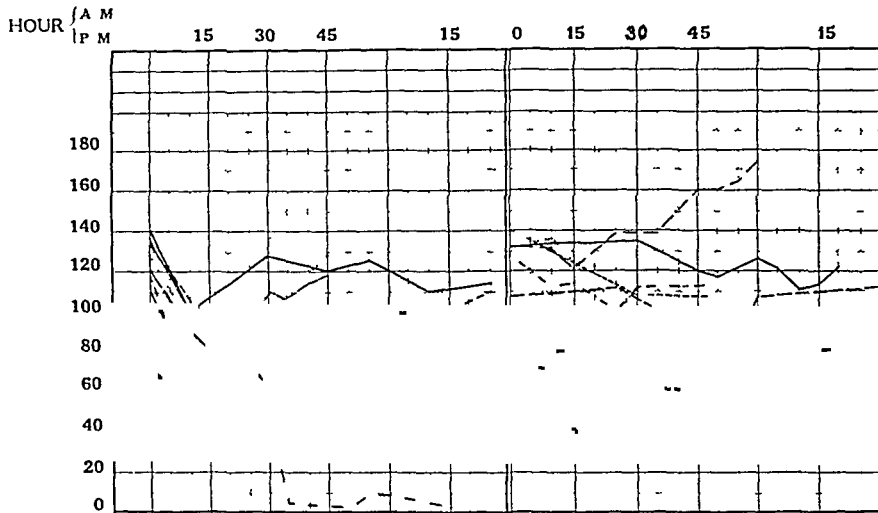
TABLE II—Operations in this series

It is impossible to foretell the blood-pressure behavior in any given case although a somewhat more uniform action has been noted where a subcutaneous injection of 50 milligrams of ephedrin has been given ten to fifteen minutes before the spinal injection.

Another of the graphs (III) indicates the blood-pressure behavior in four of our patients in whom the systolic blood-pressure was 170 or above.

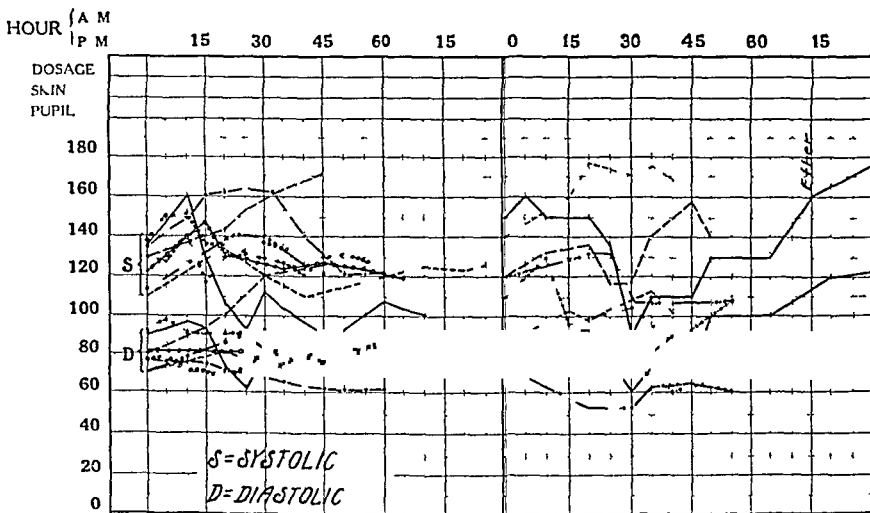
In one there was a precipitous drop from 230 to 90, in another there was a rise from 208 to 300, while in the others there was a moderate fall in pressure. The right side of this graph indicates the blood-pressure behavior in a man who had three amputations, two under nupercaine and one under novocaine.

crystals dissolved in spinal fluid. The first amputation was above the ankle, the second just below the knee, and the third above the knee. The behavior is seen to be practically the same during the three operations.



GRAPH I—On the left side are a group of blood pressures which behave more or less similarly in that there is a moderate initial fall followed by a gradual rise of both, the systolic and diastolic pressure. (The line indicating the systolic pressure matches the line indicating its associated diastolic pressure in each case.) On the right side is a group showing a more gradual fall followed by a gradual rise.

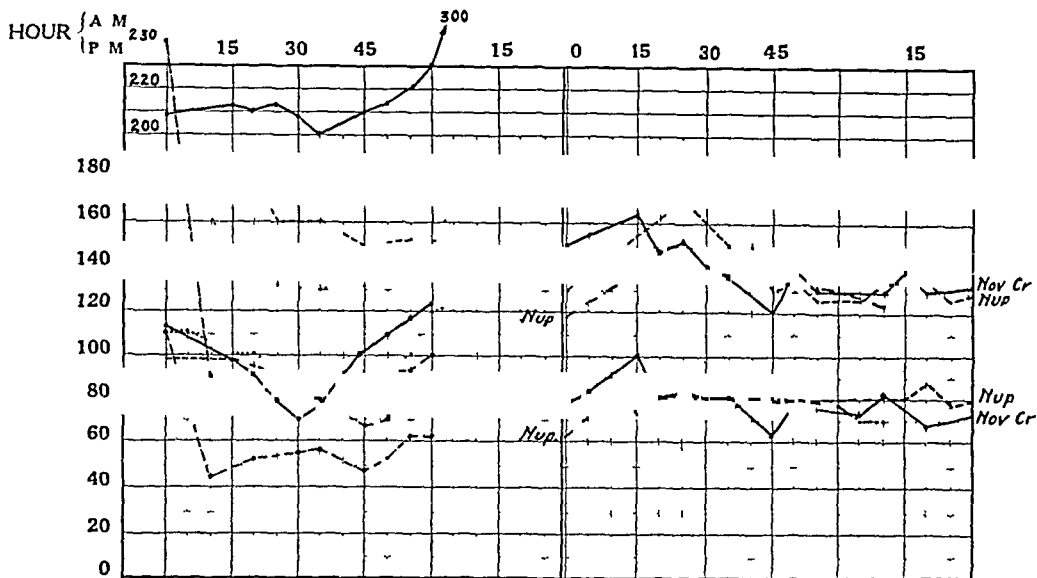
We have observed that there are four types of blood-pressure behavior under spinal anæsthesia. Graph IV illustrates the types and the percentages of each type.



GRAPH II—The left side shows an initial rise in blood pressure in each patient instead of a fall. This is probably due to the action of ephedrin. The right side of the graph shows a few irregular types of blood pressure.

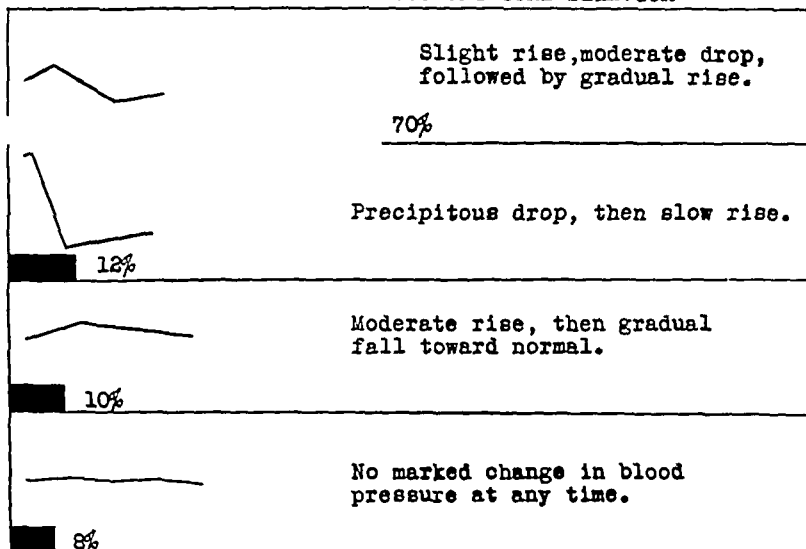
In 70 per cent of the patients there was a slight rise of pressure after the ephedrin injection followed by a moderate fall, and then a gradual rise to the pre-injection level. In 12 per cent there was a precipitous drop followed by a slow rise. In 10 per cent there was a moderate rise, but no secondary fall.

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GRAPH III—On the left the behavior of the blood pressure in four patients with hypertension is shown. On the right the similarity of the blood pressure behavior in a patient in whom nupercaine was used twice and novocaine crystals once for three amputations of the leg at different times.

## FOUR TYPES OF BLOOD PRESSURE BEHAVIOR



- (1) Average time to lowest blood pressure was 30.6 minutes.
- (2) Greatest decrease in pressure was systolic 166 points, diastolic 70 points.
- (3) Greatest increase in pressure was systolic 70 points, diastolic 52 points.
- (4) Average decrease in pressure, in those in whom there was a fall, was systolic 34 points and diastolic 22 points.
- (5) Average increase in pressure, in those in whom there was a rise, was systolic 28.3 points and diastolic 21.3 points.

## PULSE PRESSURE CHANGE FROM HIGHEST TO LOWEST B. P.

Decrease	62%	Average decrease 23 points.
Increase	30%	Average increase 12.5 points.
Same	8%	

GRAPH IV—The four most common types of blood pressure behavior are shown above. The change in pulse pressure determined at the time of the highest blood pressure and again at the time of the lowest blood pressure is shown below.



below the pre-injection level. In 8 per cent there was no marked change in blood-pressure during the entire operation. The time required for the blood-pressure to return to the pre-operative level in those cases in which there was a fall varied from forty-five minutes to twenty-four hours. It came back most slowly in the hypertension cases. The average time to the lowest blood-pressure was 30.6 minutes. The greatest decrease in systolic pressure was 166 points, and in diastolic pressure 70 points. The greatest increase in systolic pressure was 70 points, and in diastolic pressure 52 points. The average decrease in those in whom there was a fall was systolic 34 points and diastolic 22 points. The average increase in those in whom there was a rise was systolic 28.3 points and diastolic 21.3 points.

A study of the behavior of the *pulse-pressure* is also very interesting. It was determined at the time the blood-pressure was the highest and compared with that determined when the blood-pressure was the lowest with the following results. In 62 per cent of the series there was a decrease in pulse-pressure for an average of 23 points. In 30 per cent of the series there was an increase in pulse-pressure for an average of 12.5 points. In 8 per cent there was no change in pulse-pressure. These results are indicated graphically at the bottom of Graph IV. This record, we believe, is significant in that it shows that spinal anaesthesia tends to reduce pulse-pressure, and hence to stabilize circulation.

#### PULSE

Increased  20%

Constant  30%

Decreased  50%

Constant & decreased  80%

#### GRAPHIC INDICATION OF CHANGE IN PULSE RATE FROM BEGINNING TO END OF OPERATION

GRAPH V—Note the tendency of the pulse rate to decrease under spinal anaesthesia, indicating stabilization of the circulation.

Graph V indicates the change in pulse rate in the cases of this series.

In 50 per cent it decreased, in 20 per cent it increased, and in 30 per cent it remained constant. If the pulse rate in spinal anaesthesia is constant or decreased in 80 per cent of the cases, the frequently appearing statement that its effects are those of shock is not wholly true.

*Indications and Contra-indications*—We believe that spinal anaesthesia is indicated in (1) Intestinal obstruction (2) Surgery below the diaphragm on diabetics and patients with pulmonary affections or with kidney pathology. Spinal anaesthesia carries out Crile's anoci-association idea completely. In addition to these special indications we believe that spinal anaesthesia is the

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anæsthetic of choice in most urological and gynecological surgery, in amputations of the lower extremities, and in all acute abdominal conditions, except when some contra-indication is present

The contra-indications may be stated as (1) All operations above the diaphragm (2) Operations on patients with hypotension (below 95 systolic) (3) Surgery on patients with high systolic and with relatively low diastolic blood-pressure or on patients with decompensated hearts (4) Cerebrospinal infection

In surgery on patients with kidney pathology it seems to us spinal is expressly indicated Saklad has proven by comparative blood chemistry tests

OPERATION	AMT. OF ANESTHETIC	DURATION	SUPPLEMENTAL ANESTHETIC
SPINOCAINE			
Perineorrhaphy	2 cc.	To knees only	Nitrous oxide & ether
Appendectomy	2 cc.	$\frac{1}{2}$ hour	Infiltration for skin
NUPERCAINE			
Cholecystectomy	2 cc.	6- $\frac{1}{2}$ hr.	Novocaine infiltration for incision
Amputation of leg	2 cc.	8 hours	Ethylene to start with
Amputation of leg		2- hrs.	Novocaine infiltration for incision

Spinocone in 2 of 12 cases had to be supplemented by some other anæsthetic; 1 because anæsthesia reached to knees only and 1 because of return of sensation in 30 minutes.

Nupercaine in 3 of 4 cases required supplemental anæsthetic to make initial incision.

TABLE III—Cases in which spinal anæsthesia was supplemented by some other anæsthesia

on patients under ether and under spinal anæsthesia that the (1) blood urea and blood sugar were much higher with ether, and (2) that the CO combining power of blood plasma was lower when ether was used In other words, these tests show that a patient under spinal anæsthesia has a lesser protein retention, a better carbohydrate metabolism, and a lesser tendency to acidosis than under ether anæsthesia The better carbohydrate metabolism and the lesser tendency to acidosis explains why spinal is safer than ether in surgery on patients with diabetes

*Advantages and Disadvantages*—The advantages to the patient of spinal over general anæsthesia are (1) less shock, (2) less strain on eliminating organs (kidneys), and (3) fewer and less severe post-operative complications

The advantages to the surgeon are (1) complete relaxation of the abdominal muscles. This seems to us to be of extreme importance. Such relaxation allows for an easy and complete exploration of the abdominal cavity and for an easy closure of the abdominal wound. (2) There is less disturbance during the operation by the patient's attempts to vomit or strain. Although the patient may attempt to vomit, the abdominal viscera do not bulge into the wound because of the complete relaxation of the abdominal muscles.

The principal disadvantage is the shortness of the anæsthesia, making it at times necessary to use a supplemental anæsthetic such as gas or local infiltration. In our series of 220 cases, 28 (12 per cent) required supplemental anæsthesia as shown in Tables III and IV.

In three of these cases supplemental anæsthesia would not have been neces-

OPERATION	AMT OF ANÆSTHESIA	DURATION	SUPPLEMENTAL ANÆSTHESIA
Herniotomy	100 mg -2 cc	1 hour	Novocaine infiltration of skin
Hysterectomy	150 mg -2 cc	1- hour	Gas
Appendectomy	150 mg -2 cc B	55 minutes	Airform for closing
Appendectomy	150 mg -2 cc B	No anesthesia	Spinal repeated
Appendectomy	150 mg -2cc B	1st + 2nd o k	
Bilateral herniotomy	150 mg -2 cc	2- hours	Local infiltration
Bilateral herniotomy	200 mg -2½ cc	1½ hours	Local infiltration
Exploration of common duct	200 mg -3 cc B	1½ hours	Gas for closing
Appendectomy	150 mg -2 cc	1½ hours	Novocaine infiltration of skin
Cholecystectomy	150 mg -3 cc	1 hour	Ethylene and ether
Hemorrhoidectomy	100 mg -1 cc	20 minutes	Nitrous oxide
Appendectomy	150 mg -2 cc	25 minutes	Ethylene
Appendectomy	100 mg -2 cc	½ hour	Ethylene
Appendectomy	150 mg -2 cc	1½ hour	Novocaine infiltration to close
Appendectomy	150 mg -2 cc	1 hour, 20 min	Ethylene
Appendectomy	100 mg -2 cc	1 hour	Ethylene
Cholecystectomy	200 mg -3 cc B	1½ hours	Ethylene
Herniotomy	150 mg -2 cc B	1 hour	Ethylene
Herniotomy	150 mg -2 cc	1 hour	Ethylene
Herniotomy (bilateral)	150 mg -2 cc	1½ hours	Ethylene
Appendectomy	150 mg -2 cc	1½ hours	Ethylene
Cholecystectomy	200 mg -3 cc B	½ hour	Ethylene
Repair of laceration of leg	50mg -1 cc	1 hour, 10 min	Novocaine infiltration
Cholecystectomy	200 mg -3 cc	1½ hours	Ether

\* In one case of Novocaine crystals there was no anesthesia, so the injection was repeated with perfect results.

TABLE IV—Cases in which spinal anæsthesia was supplemented by other anesthesia

sary had we waited a few minutes longer before starting the operation. (See Table III.) These were cases in which nupercaine was used and the operation was started before its effect was complete. This solution requires a longer time to produce anæsthesia than novocaine, and in these cases a local injection was made for the initial incision. Two of the twelve cases in which spinocaine was used required a supplemental anæsthetic, and twenty-three of the 204 cases in which novocaine crystals were used required supplemental anæsthesia for closure. (See Table IV.)

*Complications*—Careful attention has been given to complications and post-operative developments in this series and the percentages are given in Table V.

Headache has frequently been mentioned in the literature as a post-operative development in spinal anæsthesia. The origin of it still seems to be

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obscure By some it is supposed to be due to meningismus, while others believe it is due to the loss of spinal fluid It has not been a very troublesome complication in our patients, as only three patients had headache up to the second day and three others to the third day 8.5 per cent of the total series complained of headache at some time

Four patients required catheterization for two days, two for three days, and one up to the fifth day 15 per cent in all required some catheterization The necessity for catheterizations the first day is probably due to the para-sympathetic's unopposed action on the bladder sphincter

It is interesting to note that 7 per cent of the series had a bowel movement the first day without an enema This also is probably due to the unopposed action of the para-sympathetics

Six of our patients died at intervals of from five hours to nine days follow-

POST-OPERATIVE DEVELOPMENTS		
Headache	8.5	percent
Nausea	34.	"
Vomiting	17.	"
Distention	29.	"
Catheterized	15.	"
Bowels moved (1st day) without enema	7.	"

TABLE V —Note the fairly low per cent of those in whom the distension was present and the per cent having voluntary bowel movement the first day

ing the completion of the operation We do not believe the anæsthetic to be responsible for any of these deaths A short summary of each case is given in the following

### FATALITIES

CASE I was a male, twenty-one years of age, on whom an exploratory laparotomy was performed The pre-operative diagnosis was hemolytic jaundice with an enlarged spleen The post-operative diagnosis was thrombophlebitis of the portal and the splenic vein with liver abscesses He was given 200 milligrams of novocaine crystals in 3 cubic centimetres of spinal fluid with barbotage His systolic blood-pressure ranged from 130 to 100, and his diastolic from 82 to 54 His pulse rate varied from 118 to 78 per minute He died on the eighth post-operative day of terminal pneumonia

CASE II was a male, sixty-nine years of age, who developed gas gangrene following an amputation for arteriosclerotic gangrene He was given 150 milligrams of novocaine crystals in 2 cubic centimetres of spinal fluid His systolic blood-pressure varied from 184 to 98, and his diastolic from 120 to 76 His pulse rate was 88 to 78 per minute He died of toxæmia on the fourth post-operative day

CASE III was a male, fifty-five years of age, on whom a pyloroplasty had been performed for a perforated duodenal ulcer He was given 200 milligrams of novocaine crystals in 3 cubic centimetres of spinal fluid with barbotage His systolic blood-pressure

ranged from 112 to 38, and his diastolic from 80 to 0. His pulse rate was 140 to imperceptible. He became cyanotic and complained of air-hunger. The table was lowered in extreme Trendelenburg and pure oxygen was administered. An ampoule of coramine was given hypodermically and 1000 cubic centimetres of normal saline intravenously. No ephedrine or adrenalin was used for the drop in blood-pressure. The cyanosis lasted about ten minutes. This was the most extreme drop of the entire series, in fact, it was the only case in which the systolic pressure went below 50 millimetres of mercury. He died of bronchopneumonia on the ninth post-operative day.

CASE IV was a male, sixty-five years of age, on whom about half the stomach was resected for carcinoma. He also had tertiary syphilis and generalized arteriosclerosis. He was given 175 milligrams of novocaine crystals dissolved in 3 cubic centimetres of spinal fluid with barbotage. His systolic blood-pressure ranged from 98 to 78, and his diastolic from 74 to 54. He died on the second post-operative day of bronchopneumonia.

CASE V was a male, forty-nine years of age, on whom a herniotomy for strangulated hernia was performed. The patient was moribund, having had the strangulation for five days before entering the hospital. He was given 200 milligrams of novocaine crystals dissolved in 2 cubic centimetres of spinal fluid. His systolic blood-pressure ranged from 116 to 50, and his diastolic from 72 to 20. His pulse rate was extremely rapid all through the operation. No attempt was made to resect the bowel but the gangrenous loop was drawn out through a separate, higher incision and left to be opened at a later time. He died five hours after the operation from effects of toxæmia.

CASE VI was a male, sixty-six years of age, who developed gas gangrene in a burn on his leg. An amputation was performed. He was given 150 milligrams of novocaine crystals dissolved in 2 cubic centimetres of spinal fluid. His systolic blood-pressure ranged from 130 to 122, and his diastolic from 90 to 74. His pulse rate was 120 to 130. He died on the eighth post-operative day following extension of process into the muscles of the abdomen.

In all these cases the anæsthesia was satisfactory, and, as has been said above, in none could the death be attributed to the anæsthetic.

*Facts Concerning Skin Temperatures of Legs and Feet During Spinal Anæsthesia*—In order to determine the effect of spinal anæsthesia on the temperature of skin of the feet and legs, eleven cases were studied. These were patients with no circulatory derangement. The skin temperature over the instep of the right foot was taken before the spinal injection and again after anæsthesia developed. Table VI shows the results of these tests.

The temperature was elevated some in all cases following the spinal injection. Thinking this test would be of value to determine the advisability of sympathetic ganglectomy in cases of Raynaud's and Burger's diseases, it was used on one case of Raynaud's and the result is shown in Graph VI.

The skin temperatures of the feet rose 6° and 4° after the injection. To test the reliability, the typhoid vaccine test was applied to the same patient and the same result was obtained. This patient was operated upon with excellent results.

#### REPORT OF QUESTIONNAIRE

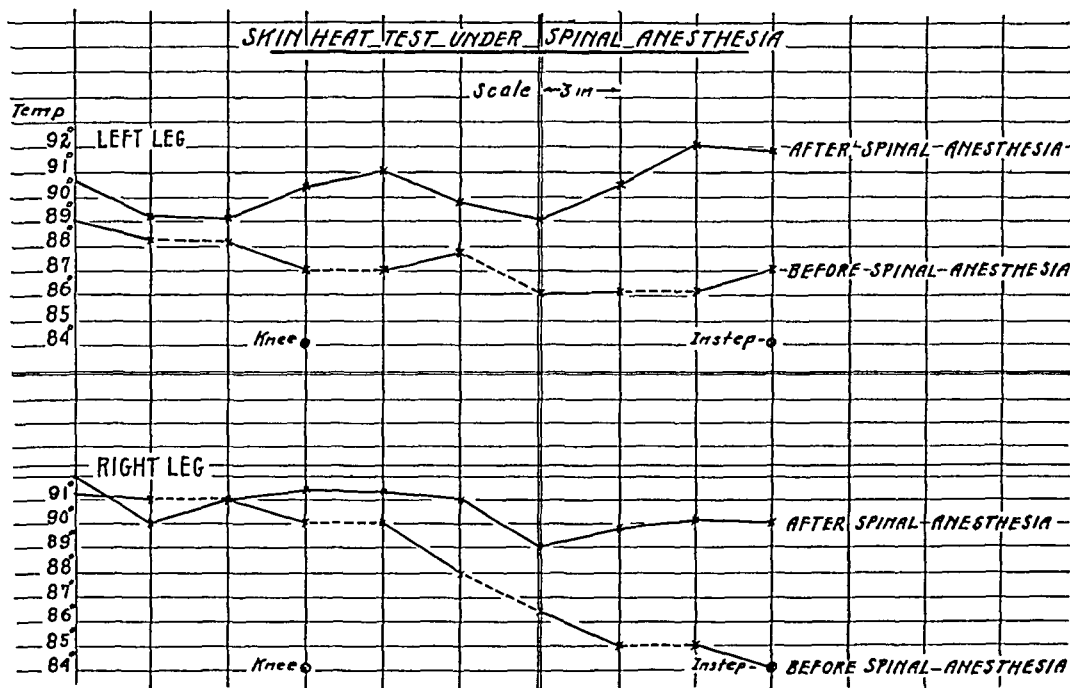
In 1927, a questionnaire was sent out by Dr Edwin Stanton, of Schenectady, New York, to several hundred American surgeons with the object of

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## SKIN TEMPERATURES ON 11 CASES WITH NO CIRCULATORY DERANGEMENT

AGE	TEMPERATURE BEFORE SPINAL INJECTION	TEMPERATURE AFTER SPINAL INJECTION
30	88° F.	92° F.
14	85° F.	89° F.
58	85° F.	92° F.
59	94° F.	94.5° F.
48	85° F.	92° F.
16	87.5° F.	90° F.
37	83° F.	86° F.
48	87° F.	90° F.
69	84° F.	86° F.
14	91° F.	93.5° F.
58	90° F.	90.5° F.

TABLE VI—This shows that the skin temperature rose in every patient under spinal anesthesia. The degree of rise shows no relationship to age or condition of vessels in this series.



GRAPH VI—This graph shows the variation of skin temperatures at various levels before spinal injection and after anesthesia developed in a case of Raynaud's disease. Temperatures were taken every three inches from the ankle to above the knee.

determining the anæsthetic most frequently used in good-risk and poor-risk cases and also to determine the extent to which spinal anæsthesia was being used at that time. There were 419 out of 622 surgeons (66 per cent) who stated definitely that they did *not* use spinal anæsthesia. There were 203 (34 per cent) who stated that they were using it in some types of cases

Answers to Questions 1 & 2	GOOD RISK CASES						POOR RISK CASES					
	Ether	N2O +O	Ethylene	Local	Spinal	Others	Ether	N2O +O	Ethylene	Local	Spinal	Others
ATLANTA	1	1 2+	3	0	4 2+		0	2+	1	5	4 2+	
BALTIMORE	5	1 5+	1	0	3	Laevartin 1 " + E	0	1 2+	5	3	4 1+	
BOSTON	12	1 4+	1	0	9 2+		0	2-	2	6 1+	13- 2+	
CHICAGO	9	9+	3 12+	0	5		2 1+	4+	7 4+	8	10	
CLEVELAND	3	4 6+	0	0	5		2	6 1+	0	2	5	
DALLAS	1	0	1	0	2		0	0	0	0	4	
DENVER	11	1+	3	0	3 1+		3	2	2	4	5 2+	
DETROIT	8	1	2	0	14 2+		0	2	2	6 1+	13 2+	
KANSAS CITY	7 2+	1 2+	0	0	2		1	2 4+	1	3	2 1+	
LOS ANGELES	6	1 7+	3 2+	0	8 1+		3	3+	1 1+	7	11 5+	
MILWAUKEE	1	0	1	0	3		0	0	0	4	1	
NEW ORLEANS	2 1+	0	2 2+	0	0		0	0	2	1+	3 2+	
NEW YORK	6	5+	2 2+	0	7 3+		2	0	0	8	13 1+	
OMAHA	1	1+	0	0	7 1+		1	0	0	1+	8	
PHILADELPHIA	2	1	0	0	4		0	1	1	2	3	
PITTSBURGH	2	1+	0	0	3		1	0	0	2	3	
PORTLAND	7	3+	3	0	2		0	4+	3	2 2+	4 1+	
SAN FRANCISCO	2	1 4+	0	0	9 6+		0	6+	0	4	12	
SEATTLE	5	1+	0	0	2		2	0	1+	3	2 2+	
ST LOUIS	5 1+	1 3+	5	1	3		0	2 3+	0	8	6	
Total	96 4+	13 54+	30 18+	1	95 19+		17 1+	18 29+	27 6+	77 6+	126 23+	
Percentage	30.3	20.3	14.5	0.3	34.5		5.4	14.2	10.0	25.1	45.1	

TABLE VII.—On the left is a tabulation of the replies to question No. 1 "What anæsthetic do you use as a rule in laparotomies in the average run of good risk cases?" On the right are tabulated the replies to question No. 2 "What anæsthetic do you use in laparotomies comprising the poor risk group?" The plus sign after the figure indicates that some additional anæsthetic is used in certain cases.

Those who were using it were, for the most part, using it in prostatectomies, amputations of the lower extremities, pelvic cases, and in diabetics. Twenty-one of them stated they reserved it for "poor-risk" cases.

Since then, spinal has become more frequently used and articles on the subject have appeared with increasing frequency in the literature. Thinking it would be of interest to determine the extent of the swing of the pendulum

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in favor of spinal anæsthesia, a similar questionnaire has been sent out to 500 members of the American College of Surgeons. The names of the surgeons were picked at random from the bulletin of the American College of Surgeons, care being taken not to pick those specializing in diseases of the eye, ear, nose and throat. The questionnaire was sent only to surgeons practising in twenty large cities of the United States covering every section of the country.

Question No. 1 was *What anæsthetic do you use as a rule in laparotomies in the average run of good-risk cases?*

Question No. 2 *What anæsthetic do you use in laparotomies in cases comprising the poor-risk group?*

Answers to Question #3							Answers to Question #4		
	SPINAL		CLASS OF CASES				INCREASE	DECREASE	NO CHANGE
	NO	YES	GOOD	POOR	OCCASIONALLY	BOTH			
ATLANTA	3	10	7	6	0	3	13	0	
BALTIMORE	9	9	3	5	3	2	11	1	5
BOSTON	4	26	11	16	5	6	28	1	1
CHICAGO	17	19	5	10	7	3	26	1	9
CLEVELAND	5	13	5	5	7	4	16	2	2
DALLAS	0	4	2	4	0	2	4	0	0
DENVER	0	18	4	7	10	3	17	0	1
DETROIT	2	24	16	16	3	11	22	2	2
KANSAS CITY	5	8	2	3	5	2	9	0	4
LOS ANGELES	5	22	9	16	5	8	23	1	3
MILWAUKEE	1	4	3	1	1	1	4	0	1
NEW ORLEANS	0	8	0	5	3	0	7	0	1
NEW YORK	0	25	10	14	7	6	23	2	0
OMAHA	0	10	8	8	1	7	10	0	0
PHILADELPHIA	1	7	4	3	2	2	7	0	1
PITTSBURGH	1	5	3	3	2	3	6	0	0
PORTLAND	7	9	2	5	3	1	10	4	2
SAN FRANCISCO	1	21	15	12	3	9	19	0	3
SEATTLE	2	5	2	4	2	3	5	0	2
ST. LOUIS	6	13	3	6	6	2	15	1	3
Total	69	261	114	149	75	78	275	15	40
Percentage	21%	79%	34.5%	45.1%	22.7%	23.6%	83.3%	4.5%	12.2%

TABLE VIII.—On the left are tabulated the replies to question No. 3 "Do you use spinal anæsthesia and if so in what class of cases do you use it?" On the right are tabulated the replies to question No. 4 "Has the opinion in your section of the country concerning spinal anæsthesia changed in the last few years?"

Question No. 3 *Do you use spinal anæsthesia and in what class of cases do you use it?*

Question No. 4 *Has the opinion in your section of the country concerning spinal anæsthesia changed in the last few years?*

The results of the questionnaire have been tabulated as shown in Tables VII and VIII.

The tabulation shows that there were 352 replies to the 500 letters (70 per cent). Twenty-two of these stated that they had retired because of poor health or for other reasons. This left 330 replies. Table VII shows the answers to questions 1 and 2 reported by cities, and is self-explanatory. Table VIII shows the answers to questions 3 and 4.



Nine of 18 answering from Baltimore do not use spinal. This is the lowest percentage of all the cities. Seven of the 18 use avertin in a certain percentage of cases. Richard Te Linde states that 3 deaths in 15 spinal anæsthesias in 1929 caused the surgeons in Baltimore to look upon it with disfavor, and he also states that, except for the Brady Urological Institute, not much spinal is used at Johns Hopkins. Other Baltimore surgeons, including Shipley, Toulson, and Blake, do use it, some of them being very enthusiastic over it.

In Atlanta, Georgia, most of the surgeons answering the questionnaire use it to some extent. Dr. George W. Fuller uses it in practically all surgery below the diaphragm in both private and service cases. He states that some of the hospitals at Atlanta are using it in about three-fourths of the laparotomies.

In Boston, a large majority use spinal anæsthesia. Several volunteered the statement that novocaine crystals are being used almost to the exclusion of other preparations, such as Pitkin's solution, *etc*. Dr. A. R. Kingston uses it below the diaphragm in nearly 90 per cent. of his cases. He is one of several throughout the United States who state that Cæsarian section is a contra-indication to spinal anæsthesia. He states that he has, however, done Cæsarian operations under spinal without the slightest trouble, and is of the opinion that if it is used at all it should be used only in small dosage. Dr. J. S. White, of the Massachusetts General Hospital, states that because the incidence of pulmonary complications is as great under spinal as under ether, he is using it only in amputations of the leg or in perineal operations or where a low spinal can be used.

The Chicago surgeons, as a whole, are rather conservative in the use of spinal anæsthesia. Jonnesco's first case, many years ago, at the Cook County Hospital demonstration, died, and as a result spinal anæsthesia has gained favor slowly. Dr. James T. Case states that the popularity is gradually increasing now, however. He has used it in 1,700 patients, most of whom were gynecological cases. Ethylene, in both good- and poor-risk cases, is being used more in Chicago than in any other city of the country. Doctor Culbertsen, of Chicago, thinks that in the more difficult abdominal cases, with adhesions, *etc*, nothing gives the excellent intestinal relaxation that is present with spinal anæsthesia.

Few of the Cleveland surgeons use spinal as the anæsthetic of choice. Professor Cutler, of the Western Reserve University, employs it where the renal function is poor and in diabetics. He also uses it in prostatectomies and amputations of the leg. William Lower, of the Cleveland Clinic, uses it in all his urological cases unless there is some contra-indication.

Detroit surgeons are more enthusiastic concerning spinal than surgeons of any other large city, with the possible exception of New York and San Francisco. Clark D. Brooks has used it in 4,000 cases and uses novocaine crystals only.

In Philadelphia, the men doing a large volume of surgery are generally enthusiastic concerning spinal. Dr. Wayne Babcock, one of the pioneers in

spinal anæsthesia, uses novocaine and stovaine with alcohol to lighten the specific gravity Doctor Deaver has used it in about 5,000 cases and prefers Pitkin's solution

Dr J C Negely, of Los Angeles, is one of the pioneers in spinal anæsthesia on the coast, having reported 5,500 cases up to 1925 He uses it in all classes of cases except when the systolic blood-pressure is at or below 100 Los Angeles surgeons generally favor spinal anæsthesia

In New Orleans, Doctor Matas has been a pioneer in the use of spinal anæsthesia He states that he uses it in all operations on the extremities, in genito-urinary and gynecological cases, and as a rule in all operations below the waist, including those for intestinal obstruction He also states that spinal anæsthesia's popularity is still increasing in New Orleans Doctor Danna, of New Orleans, has used spinal anæsthesia for twenty-eight years and is using it more and more, especially in the last three or four years Dr Anton Ochsner, of that city, is using it especially in his poor-risk cases and in laparotomies where relaxation is especially desired

In New York City spinal is used more than any other anæsthetic, according to returns from the questionnaire Neocaine is used more extensively there than other preparations Gaston Labat, of New York, has long been an advocate of spinal anæsthesia, and has done much to bring it into national favor

The surgeons of Omaha are, almost to a man, in favor of it and many use it in both good- and poor-risk cases

Spinal anæsthetics are used conservatively in Portland, Oregon Drs Robert Coffey and William Holden state that they use it cautiously and usually in cases where there is some pulmonary risk

San Francisco surgeons as a rule are extremely partial to spinal anæsthesia Nine of the 22 men answering the questionnaire state that they use it in both good- and poor-risk cases One states that he uses it in 95 per cent of his laparotomies

Dr E A Graham, of Washington University School of Medicine, states that although he is not using spinal in many cases, other members of the department use it extensively in gynecological and genito-urinary and lower extremity cases He also states that more spinal is being used in St Louis than formerly

Some of the unsolicited facts and expressions obtained from the questionnaire are

(1) There were 26 of the 330 surgeons who expressed themselves as favoring novocaine crystals dissolved in spinal fluid in preference to other solutions

(2) There were 14 who expressed themselves as favoring Pitkin's solution of spinocaine

(3) There were 3 who expressed themselves as favoring neocaine

(4) There were 10 who volunteered the statement that Cæsarian section was a contra-indication for spinal anæsthesia

(5) Urologists, as a group, seem most enthusiastic over spinal anæsthesia

(6) Intestinal obstruction was the condition most frequently mentioned in which spinal was the anæsthetic of choice

(7) There were 275 of the 330 surgeons who stated that spinal anæsthesia is increasing in popularity in their section of the country, and but 15 state that it is decreasing

(8) There were 40 who stated that they had observed no change in the number of surgeons using this type of anæsthesia

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# SPINAL ANÆSTHESIA ON A GENERAL SURGICAL SERVICE \*

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DURING the past three years four hundred spinal anæsthesias have been administered on the Second Surgical Service (Cornell) of Bellevue Hospital. A complete record of each case was kept during the patient's course in the hospital to make possible an unbiased decision as to its preference over general anæsthesia, its indications and contra-indications.

The method used has been the dissolving of 40 to 170 milligrams of novocaine crystals in 2 to 20 cubic centimetres of spinal fluid, depending upon the level of anæsthesia required. Only the third and fourth lumbar interspaces were used with the exception of two thoracoplasty cases where a higher level was attempted. Spinocaine was used for a period when novocaine crystals were not available in the hospital.

An analysis of the records was made with the following factors in mind: 1, Mortality; 2, post-operative complications; 3, Disturbing symptoms directly due to spinal anæsthesia, A, Low blood-pressure, B, Headaches, C, Psychic disturbances; 4, Failures or semi-failures of anæsthesia; 5, uniformity or expectancy of level and duration of anæsthesia under identical conditions; 6, Indications or contra-indications for spinal anæsthesia.

1 and 2—Only those cases occurring between the months of November and May of both respective years were included in the statistical series. The remaining 180 cases not tabulated were between the months of May and October. There was no pneumonia incidence. During the winter of 1928-1929 pneumonia and post-operative pneumonia were extremely prevalent in New York City. During the following winter, 1929-1930, its incidence was very low, in fact less than usual.

The statistics for the first winter, 1928-1929, show a mortality of 13.3 per cent and a pneumonia incidence of 9.16 per cent with six deaths. 11.7 per cent of the deaths were abdominal and chest operations.

The winter of 1929-1930 showed a mortality of 5 per cent and a pneumonia incidence of 3 per cent. However, only five cases of the series were abdominal and chest operations, as against thirty-four for the previous year.

A control series in both years receiving general anæsthesia showed approximately the same pneumonia incidence but a lower mortality.

Only two deaths could have been due directly to spinal anæsthesia, one a cholecystectomy who died seven hours following operation with apparent respiratory failure, and one a thoracoplasty who died fourteen hours following operation from the same cause.

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\* Prepared for Graduate Fortnight. New York, Academy of Medicine, 1928-1929.

3—20 per cent of the first series and 16 per cent of the second series had disturbing symptoms directly due to the spinal anæsthesia while on the operating table. The symptoms varied from slight shock with slight mental discomfort to severe shock, nausea and vomiting, and extreme mental disturbance and discomfort. This occurred with the patient's head both level and lowered and with manometer readings of spinal fluid pressure taken and the injection made at a uniform pressure—10 millimetres of mercury obtained by the amount of spinal fluid withdrawn. An anæsthetist was needed just as much with spinal anæsthesia as with general anæsthesia.

4—In 10 per cent of the first series and in 7 per cent of the second series the spinal anæsthesia failed completely or had to be supplemented with general anæsthesia.

5—8 per cent of the first series and 5 per cent of the second had severe headaches for the first few days following operation with extreme discomfort.

6—Although every method which has been suggested, including the use of spinocaine, was used, no uniformity of level or duration of analgesia was ever obtained. One patient who received 170 milligrams dissolved in 20 cubic centimetres of spinal fluid had complete analgesia of the entire body and died seven hours following the operation from shock and respiratory failure. The next patient receiving the identical amount in the same manner had to have general anæsthesia before the peritoneum could be opened, his analgesia lasting about fifteen minutes. Analgesia varied from none at all to one hour and forty-five minutes under identical technic. This variable factor could not be corrected.

Traumatic cases already in shock were never given a spinal anæsthesia after the first two cases due to the fact that it deepened their shock if an immediate operation had to be done or caused it to recur if operation was postponed until it had subsided.

The conclusions that can be drawn from this series of cases are the following:

1 Spinal anæsthesia, 40 to 120 milligrams of novocaine, in the fourth lumbar vertebral space for lower extremity, rectal, perineal, and hernia operations is safe and satisfactory. The post-operative complications are as numerous as with general anæsthesia. There is also a certain percentage of failures.

2 Spinal anæsthesia, 120 to 170 milligrams of novocaine, dissolved in 2 to 20 cubic centimetres of spinal fluid and injected in a higher level for abdominal and chest operations is not safe. The post-operative complications are as numerous as in general anæsthesia. The shallow respiratory excursions would accentuate rather than lessen the possibility of post-operative pneumonia. The only post-operative lung abscess which has occurred on the service was a gastric resection under spinal anæsthesia supplemented by nitrous oxide for the last half hour of the operation. Those patients who go into shock with resultant lowered tissue resistance are more susceptible to infection. The technical danger of injuring the cord at a higher level is always present.

## SPINAL ANÆSTHESIA

3 The poor surgical risk, with constitutional disease, damaged heart vessels or kidneys, is a still poorer risk with spinal anæsthesia

4 Spinal anæsthesia is definitely contra-indicated in the patient already in traumatic shock or soon after the subsidence of his shock

5 Spinal anæsthesia is strongly indicated in the elderly patient suffering from an incarcerated hernia, for two patients aged seventy-eight and eighty had a spontaneous reduction within fifteen minutes following the injection when all other methods failed

6 It is by far the analgesic of choice in all fractures of the lower extremity and pelvis not in shock necessitating the use of the fracture table and application of plaster

7 It is strongly indicated in acute intestinal obstruction for those not mechanical will be relieved and those mechanical will make the operative procedure easier

8 In selected types of patients it has proven very satisfactory in pelvic operations

TABLE OF OPERATIONS  
*In Which Spinal Anæsthesia Was Used*

	1928-1929	1929-1930
1 Rectal	24	48
2 Hernia (repair)	32	35
3 Lower extremity	26	13
A Compound fractures and fractures		
B Infections—cellulitis—osteomyelitis		
C Amputations		
4 Cholecystectomy	4	0
5 Abdominal hernia	3	0
6 Appendectomy	7	1
7 Intestinal obstruction	5	1
8 Thoracoplasty	3	0
9 Gastro-enterostomy	5	1
10 Strangulated hernia	2	0
11 Exploratory laparotomy	2	1
12 Gastric resection	2	0
13 Gastrostomy	2	0
14 Tracheloectomy	1	0
15 Inoperable carcinoma	1	0
16 Carcinoma of cæcum	1	0
	120	100

NOTE—Because of the high incidence of post-operative pneumonia and the uncertainty of duration of an anæsthesia in the first series, spinal anæsthesia was discontinued in upper abdominal operations

# SPINAL ANÆSTHESIA WITH NUPERCAINE AND PROCAINE

## A COMPARATIVE STUDY

BY AUGUSTUS HARRIS, M D , AND LEO G GOLDBERG, M D  
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FROM THE DEPARTMENT OF UROLOGY LONG ISLAND COLLEGE HOSPITAL

ALTHOUGH we have been using procaine spinal anæsthesia extensively and successfully in urologic surgery for more than fifteen years, we have recently been trying nupercaine following a preliminary report of its use by Keyes and McLellan <sup>†</sup>

We were impressed with the reports of the German investigators concerning this compound, derived from quinolin, particularly in regard to the intensity of anæsthesia. It is to be noted, however, that not all the reports showed uniformly successful results, also where failures were recorded, faulty technique was generally blamed as the cause of failure.

Some have found that a 1-2000 solution for infiltration purposes, despite statements to the contrary, does not equal the anæsthetic activity of 0.5 per cent procaine. Suffice it to say, that, for infiltration purposes, in a limited series of cases, we have found 1 per cent procaine more satisfactory and have given up the use of nupercaine by this route.

Nupercaine has been used for spinal, caudal, paravertebral and infiltration anæsthesia, also for topical application to mucous membranes.

We have been impressed with the statement that the substance, prepared by Karl Miescher, is five times more toxic than cocaine and having ten times the activity of the latter drug. However, subsequent work on animals, together with its clinical use, would indicate that the margin of safety in its use, as prescribed, is much greater than the figures given.

With the maximum dose of cocaine fixed at 50 milligrams, the maximum dose for nupercaine would, therefore, be 10 milligrams. This latter dose is contained in 2 cubic centimetres of 0.5 per cent solution (used by us in ampoule form for spinal anæsthesia). This dose would also be contained in 10 cubic centimetres of 1-1000 solution and 20 cubic centimetres of 1-2000 solution.

It is to be noted that solutions in salt solution can be sterilized at 221 degrees F for one half hour without impairing their activity. The sodium chloride must, however, contain no soda or sodium bicarbonate, and, when kept, should be contained in alkali-free glass. It has been recommended that five drops of dilute HCl be added to containers of solution of 1-1000 or 1-2000.

We have not seen the hyperæmic condition of the skin or possible skin necrosis said to have followed its use. It has been suggested that a few drops of adrenalin be added to the solution before injection to correct this effect.

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<sup>†</sup> Keyes, E L, and McLellan, A M. *Am J Surg*, vol 18, p 1, July, 1930.

## SPINAL ANÆSTHESIA

In the following series of cases, exactly the same technic of spinal injection was used in all, the same that we have been using on the service for many years. Each patient received morphine and scopolamine, thirty to forty-five minutes before operation, and  $\frac{3}{4}$  grain of ephedrine just prior to spinal injection. A No. 20-gauge needle was usually passed through the second or third lumbar interspace, and, in some kidney cases, in the first lumbar interspace, always with the same "snap" of the dura and withdrawing the spinal fluid slowly into a 3 cubic centimetre syringe and carefully mixing.

### ANALYSIS OF 50 CONSECUTIVE NUPERCAINE SPINAL ANÆSTHESIA CASES

Successful—41 (82 per cent)

Failures—9 (18 per cent)

#### *Time of Induction of Anæsthesia (Excluding 8 Failures)*

5 minutes — 18 cases	35 cases had good anæsthesia within 10 minutes	
10 minutes — 17 cases		
15 minutes — 4 cases		
20 minutes — 1 case		
25 minutes — 1 case	Anæsthesia in these last 3 cases lasted only $1\frac{1}{2}$ hours	
35 minutes — 1 case		

#### *Duration of Anæsthesia (Excluding 6 Failures)*

1 hour — 2 cases (only 1 cubic centimetre was used, or $\frac{1}{2}$ dose)		
$1\frac{1}{2}$ hours — 3 cases		
2 hours — 11 cases		
$2\frac{1}{2}$ hours — 10 cases		
3 hours — 6 cases		
$3\frac{1}{4}$ hours — 1 case		
4 hours — 1 case		
Unknown—8 cases (more than 2 hours)		

#### *Length of Operating Time (Excluding 7 Failures)*

20 minutes — 6 cases	65 minutes — 3 cases	
30 minutes — 9 cases	80 minutes — 1 case	
45 minutes — 17 cases	85 minutes — 1 case	
60 minutes — 5 cases	1 hour 40 min — 1 case	

#### *Type of Operation*

Kidney—16 cases, with 4 failures  
 Bladder—11 cases, with no failures  
 Prostate—9 cases, with no failures  
 External genitalia—11 cases, with 3 failures  
 Transplantation of ureters (Coffey method)—3 cases, with 2 failures

#### *Headache*

Sixteen cases or 32 per cent had a moderately severe or a severe headache, all requiring codeine or coal tar preparation.

#### *Duration of Headache*

Lasting 2 to 6 hours — 2 cases	Lasting 24 hours — 2 cases
Lasting 6 to 9 hours — 2 cases	Lasting 2 days — 3 cases
Lasting 12 hours — 6 cases	Lasting 3 days — 1 case

Seven cases had moderate degree of nausea and vomiting. This has not been troublesome.



# HARRIS AND GOLDBERG

## ANALYSIS OF 50 CONSECUTIVE PROCAINE SPINAL ANÆSTHESIA CASES

1—Failures, total and partial—2 cases or 4 per cent

Insufficient duration anæsthesia—4 cases or 8 per cent

### 2—*Type of operation*

Kidney—9 cases, with no failures

Bladder—14 cases (with two imperfect anæsthesia)

Prostate—19 cases (with two imperfect anæsthesia)

External genitalia—8 cases (with two imperfect anæsthesia)

3—"Puncture" headache rarely occurred in any of our procaine cases (including a previous large series)

4—The induction-time was definite, more rapid, but anæsthesia of much shorter duration than with nupercaine

*Analysis of six imperfect procaine anæsthesia cases* Failures 1—Second-stage prostatectomy Procaine 120 milligrams After ten minutes, gas-oxygen anæsthesia was used Operation lasted thirty-five minutes

2—Cystotomy and fulguration of bladder carcinoma Procaine 240 milligrams Operation started five minutes after spinal injection After waiting twenty minutes, gas-oxygen anæsthesia was used to complete operation and obtain relaxation Blood pressure did not fall (120/60) Operating time, 55 minutes

Insufficient duration of anæsthesia (procaine) 1—Bilateral hydrocele and varicocele Procaine 120 milligrams Induction-time five minutes with good anæsthesia Operating time, thirty-five minutes Morphine sulphate grains  $\frac{1}{4}$  given after thirty minutes as sensation began to return No general anæsthesia used

2—Resection of carcinoma of prostate (radiotherm knife) Procaine 120 milligrams Induction-time, five minutes Operating time, sixty-four minutes Gas-oxygen anæsthesia used five minutes before completion of anæsthesia (Anæsthesia lasted fifty-five minutes Then blood pressure rose from 120 to 140 suddenly)

3—Bilateral epididymotomy Procaine 120 milligrams Induction-time, five minutes Blood pressure, 100/50 after five minutes, 135/90 after fifteen minutes, 120/70 after twenty-five minutes Operating time, sixty minutes Light gas-oxygen-ether was begun ten minutes after incision was made because patient was very uncomfortable and apprehensive Usual pre-operative medication of morphine sulphate grs  $\frac{1}{4}$  Scopolamine grs  $\frac{1}{200}$  had been given

4—Cystotomy and resection of bladder carcinoma Procaine 120 milligrams Induction-time, five minutes Operating time, seventy minutes Pain felt after thirty-five minutes Gas-oxygen given at end of forty minutes

*Analysis of nupercaine failures* Failures 1—External urethrotomy Waited twenty minutes Gas-oxygen used (Patient apprehensive)

2—Nephrectomy Waited ten minutes with no anæsthesia at the end of this time General anæsthesia used

3—Coffey ureteral transplantation Waited forty minutes General anæsthesia used

4—Hydrocele No anæsthesia after fifteen minutes Light gas-oxygen used

Partial failures (nupercaine) 1—Nephrectomy Waited only eight minutes Complained of pain Supplemented by light gas-oxygen which was stopped ten minutes before end of operation (Patient apprehensive)

2—Nephrotomy Waited twenty minutes Patient complained of pain during operation No supplementary anæsthesia given (Apprehensive) Second operation under 150 milligrams procaine (ureterotomy) with perfect anæsthesia

3—Ureterotomy Waited twenty minutes Light gas-oxygen given

4—Coffey ureteral transplantation Waited twenty-five minutes Light gas-oxygen used Some anæsthesia present after three hours Operation required two hours (Patient very apprehensive)

## SPINAL ANÆSTHESIA

5—Orchidopexy Pressure-sensation felt throughout operation Uncomfortable, but no general anæsthesia given

Two cases given 1 cubic centimetre ( $\frac{1}{2}$  dose) of nupercaine, had anæsthesia for only one hour These were the first two cases in the series when only half dose was used Since then, we have been using 2 cubic centimetres routinely

A case of Coffey ureteral transplantation Complained of some pain in the last half hour Operating time, two hours, ten minutes No additional anæsthesia was given A case of partial resection of kidney, with operation time of sixty-three minutes, complained of pain in last twenty minutes No additional anæsthesia was necessary (Had rather marked distention for forty-eight hours) A one-stage prostatectomy case, died of paralytic ileus thirty-six hours following operation Twenty-three minims of nupercaine were used (Full dose thirty minims) Anæsthesia lasted two and one-half hours Death did not appear to have any relationship to spinal anæsthesia A first-stage cystotomy operation, had good anæsthesia At the second operation (prostatectomy) induction took twenty-four minutes and patient complained of some pain throughout, but no additional anæsthesia was given (Crabtree perineal prostatectomy, forty-seven minutes' operating time)

*Conclusions* —(1) It is worthy of note that, where nupercaine anæsthesia was partial, the patients were notably apprehensive

(2) In comparing the individual blood-pressure curves during operations, as many variations were found with nupercaine as were present with procaine

(3) Hourly blood-pressure readings were taken following operation, but so little variation was found, that this was discontinued after six cases

(4) For six to eight hours following operation the majority of patients having nupercaine were notably comfortable without narcotics This was in contrast to the procaine cases

(5) No death occurred which could be attributed to nupercaine injection

(6) Induction time is slower with nupercaine in many cases than with procaine It might be wise to inject the drug thirty to thirty-five minutes before the operation is begun

(7) "Puncture" headache appears to be much more frequent with nupercaine than with procaine

(8) We began by using 1 cubic centimetre 1-200 solution of nupercaine and gradually increased to 2 cubic centimetres, and now feel that the full dose is perfectly safe for routine use

(9) In view of the variable results obtained in our first fifty cases, we believe that nupercaine for spinal use should be reserved for operations lasting over an hour, after which time the effects of procaine, in doses of 120 to 150 milligrams (doses we usually employ) may wear off

(10) We have noted a peculiar persistence in some nupercaine cases of the sense of touch or contact, with obliteration of pain sense

(11) A number of neurotic patients complained and worried over the persistence of paralysis of the legs, after operation, following nupercaine

(12) Perhaps the ventral position would aid in effecting anæsthesia following injection We have not tested it

(13) The ideal to be reached is obliteration of pain sense without affection of the motor fibres The use of small doses of either nupercaine or procaine

to exclude the motor fibres would appear to be impractical for major surgical operations

(14) The action of nupercaine is definitely more variable and uncertain in our hands

(15) We have not been disposed to try the method suggested of injecting a mixture of procaine and nupercaine

(16) Nausea or vomiting has been exceptional and there was no evidence of frank toxic reaction on the part of any patient in this series

(17) Continued investigation in spinal anaesthesia should now be carried on by the physiologist, pharmacologist and chemist working in conjunction with the clinician

# SUTURING THE BONES OF THE FOREARM\*

BY ISADORE ZADEK, M D

OF NEW YORK, N Y

I AM presenting a method of bone suture especially applicable to the bones of the forearm which I have found to be effective, and which, so far as I know, is original. A review of the literature back as far as 1890 discloses no similar report.

The experience of others has, no doubt, been the same as mine, that is, that where open reduction has been indicated, one has been forced to put in non-absorbable material, either in the form of a Lane plate, or a wire, or he may have attempted to "notch" the bones in the hope that fixation would be sufficiently secure. This "notching" is open to the same objections that characterize the use of a single suture.

The third alternative has been that of putting in absorbable suture material, and the usual material has been kangaroo tendon.

Considering only the last method. After drilling the bone and reducing the fracture, and tying the suture, one has proceeded to attack the other bone, and my experience has been that, during the manipulation incidental to the reduction of the second bone, the suture in the first bone has become loosened and fixation has been insecure. The point has been raised as to whether or not it is necessary to do an open reduction on both bones of the forearm, the radius being larger and more important. From my experience I consider it desirable to treat both bones alike.

The particular technic used (Fig. 1) has been to drill the bone near the fractured ends, and, instead of inserting one suture, to use two long sutures passed through these drill holes so that the free ends are on opposite sides of the bone. The two sutures are tied simultaneously and the fixation obtained by the use of two sutures is far superior to that obtained from the use of one suture. The print, with no special attempt to obtain this, shows that the planes in which the radius and ulna were drilled were different, which also adds stability. I have uniformly sutured the radius first and have left the wound open and then repeated the performance on the ulna. Uniformly, the radius has held, and, in spite of tremendous force which often has to be applied in reducing the second bone, especially if the fracture is some days old, the radius was always found to have maintained its reduction after the suture of the second bone.

My own preference has been for the use of No. 4 chromic catgut, instead of kangaroo tendon, as the kangaroo tendon is not uniform in size, frays

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\* Presented at the Orthopedic Section of the New York Academy of Medicine, April 24, 1931.

easily, and cannot be tied securely, all of which desirable characteristics are present in the chromic gut

Figures 2 and 3 are X-ray films of a typical case in which this method of suture has been followed. All of these operations were done under the tourniquet and it is interesting to note that three of the seven cases presented the post-operative complication of loss of function of the nerves of the hand and fingers, which persisted over a period of about three weeks when

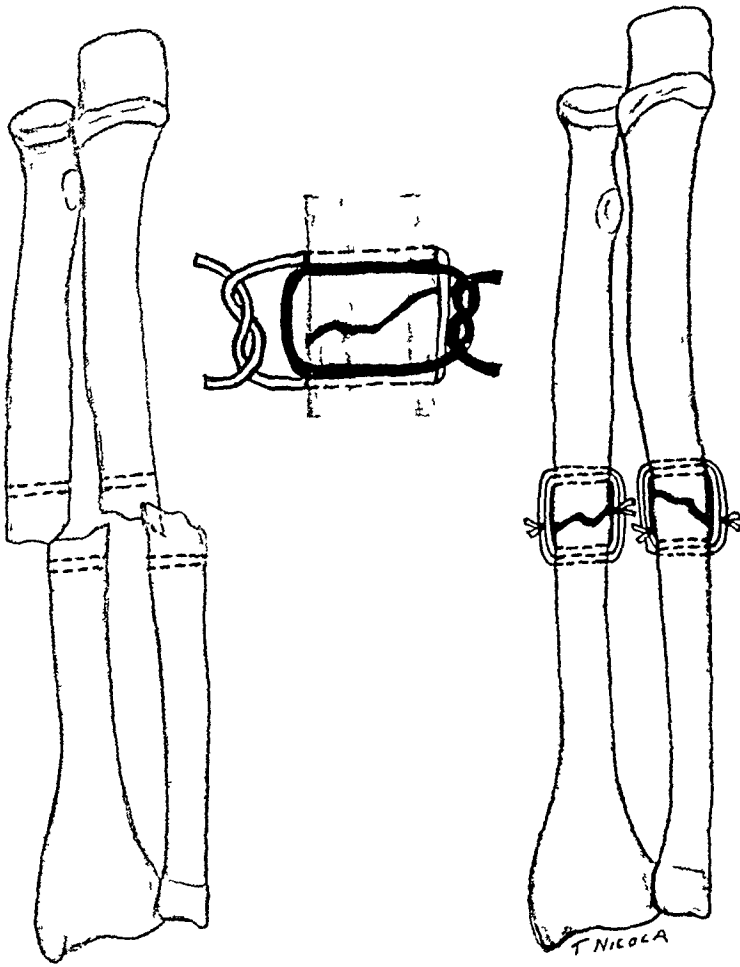


FIG 1.—Method of insertion of the double suture

the sensory and motor power had returned almost completely. They were all immobilized in circular plaster-of-Paris bandages. These bandages were left on for five weeks. The bandages extended from the metacarpophalangeal joints to the axilla, with the wrist in slight dorsal flexion, the forearm supinated, and the elbow at a right angle. Care was taken that the bandages were not tight, so that this lack of nerve function was due to the tourniquet and not to the plaster-of-Paris bandage, as the fingers were but slightly swollen and their color was good. In spite of this in these particular cases the bandages

## SUTURING THE BONES OF THE FOREARM

were split through down to the skin without any change in function. Ultimately their nerve restoration was complete.

In one case in which the ulna was in fair position I did not suture this. The subsequent result was considerable displacement of the ulna, after the radius had been perfectly reduced. Interestingly enough, this patient developed an ulnar-nerve paralysis, both sensory and motor, with claw hand and nearly three months after his fracture, I explored the ulnar nerve at a



FIG 2—J H Fracture of the bones of the forearm Before reduction

FIG 3—J H Fracture of the bones of the forearm One month later after the removal of the plaster of Paris bandage

point several inches above the wrist joint at the site of fracture, and found the branches firmly imbedded in a mass of scar tissue. It was impossible to completely free these nerve branches as they began to fray out. I stopped after doing what was to me a very unsatisfactory operation. A day or so after the operation the patient was quite sure he had better control of the affected fingers though objectively I could distinguish no difference. Ten days after operation his sensation in the distribution of the ulnar nerve was complete though I could still find no change in the motor function. Two months later

the return of both motor and sensory function was complete. This return of function was an agreeable surprise to me as I felt that the operative procedure was inadequate. All of these patients have made complete recoveries, with two exceptions, the two most recently operated upon. They are joining up satisfactorily at the present time, though union has been delayed. There was an infection in one case and subsequently several sequestra were extruded, but the bony union and function were not impaired.

I have, on several occasions, as, for instance, in the patella or in a clavicle, used two sutures with the knots tied on the same side of the bone to obtain additional security. I feel that this is a desirable method of suture. This is obviously not the method that I am describing.

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# TRANSACTIONS

OF THE

## PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD MAY 4, 1931

The President, DR GEORGE P MULLER, in the Chair

CALVIN M SMYTH, JR, M D, Recorder

### INTRAHEPATIC CALCULUS—CALCULOUS CHOLECYSTITIS COMMON-DUCT STONE

DR HUBLEY R OWEN reported the case of a woman who was admitted to the hospital of the Woman's Medical College, June 9, 1930, with the chief complaint of pain in the right side of the abdomen and back. The present illness began two months before with pain in the epigastrium which was at first referred to the left axilla then to the right lower costal margin, at times radiating to the left shoulder blade. The pain was inconstant and had no relation to the taking of food. There were associated headache and nausea. She had had the usual diseases of childhood, and pneumonia. She was operated upon at another hospital in 1921 for gall-stones, at which time cholecystostomy was performed. On admission there was no evidence of jaundice. Generalized tenderness over the abdomen especially over the region of the gall-bladder and epigastrium. This tenderness extended to the umbilicus. The liver was enlarged and extended almost to the level of the umbilicus. The spleen was not palpable. One hour after admission she had a severe attack of biliary colic, she was nauseated, vomited and the temperature arose to  $103^{\circ}$ . Her blood sugar on admission was 112.5, creatinin 1.4, chlorides 436, and blood urea 32 per 100 milligrams blood. On July 7, 1930, the blood sugar was 91, urea 17, and chlorides 400. The temperature gradually fell to normal and she was operated upon June 16, 1930 seven days after admission.

At the time of operation the liver was found to be greatly enlarged. The gall-bladder was large, thick-walled and contained innumerable calculi. The common duct was dilated and contained a large stone at its distal end. The gall-bladder and the common-duct stone were removed. A calculus was felt in the hepatic duct. An attempt was made to remove this calculus with a pair of Kelly forceps but the calculus crumpled and could be only partly removed. On palpation of the dome of the enlarged liver, an area of induration could be felt. With bi-manual palpation, one finger in the hepatic duct, the other hand being placed on the area of induration in the dome of the liver, it was found that the calculus was deeply embedded within the liver substance. The dome of the liver was incised with the cautery. A large branching calculus, 7 centimetres long and 3 centimetres in circumference, was removed through the incision in the dome of the liver. The calculus extended down the right hepatic duct. A "T" tube was placed in the common duct and a cigarette drain was placed to the incision in the liver which was not closed. Packing was unnecessary as there was no hæmorrhage. All sutures were removed ten days after the operation. There was very scanty drainage from the wound. After a rather stormy convalescence the patient was discharged on the twenty-ninth day after operation.



The reporter remarked that cases of hepatic-duct calculi are not uncommon. Intrahepatic calculi, especially of large size, are rather rare. Either may occur in the absence of calculous cholecystitis.

Frerichs<sup>1</sup> states that gall-stones in the interior of the liver and in branches of the hepatic duct are rare but quotes Morgagni who collected a series of observations from the works of Plater, Fallopius, Dodonoeus, Columbus, Paysch and others showing concretions which have been found in the interior of the liver. Most of these concretions were large, round stones and more rarely branched coral-like concretions which form casts in the ducts and are sometimes solid but at other times hollow. These concretions may give rise to inflammation, ulceration of the ducts also to hepatic abscesses and pylephlebitis.

There are said to be many specimens of multiple intrahepatic calculi in the museums of London and Westminster Hospitals. Beer<sup>2</sup> dissected 250 livers of patients who had succumbed to gall-bladder disease and found six cases of definite intrahepatic stone formation, that is, in 2.5 per cent.

Thudichum<sup>3</sup> reported six cases of large branching intrahepatic calculi. Another case of intrahepatic calculus was reported from St. George's Hospital of a man who died with diabetes from a secondary pancreatitis.<sup>4</sup> Vachell and Stevens<sup>5</sup> reported a case in which there were 520 calculi within the liver substances and the ducts. The largest was one and three-quarters inches long.

Intrahepatic calculi are chiefly composed of bilirubin calcium, whereas stones found in the gall-bladder are usually cholesterol stones. Because of this difference in the consistency of the calculi and because of the fact that intrahepatic stones may occur independently of calculi in the gall-bladder, the etiology requires further discussion. Beer<sup>2</sup> states that intrahepatic stones are probably formed in the liver rather than having been formed originally in the gall-bladder because of the fact that the stones removed from the hepatic duct and liver differ in shape, color and character from those usually found in the gall-bladder. Moreover, as mentioned above in many cases reported of intrahepatic stone there have been no stones in the gall-bladder. Undoubtedly the intrahepatic calculi and the calculi found within the hepatic ducts must originate in the liver. In some cases of intrahepatic calculi, jaundice is present. In others, it is absent as in Draper's case. In Hawkes' case<sup>6</sup> there was slight jaundice. In this case the gall-bladder had been previously removed. The patient left the hospital two weeks after cholecystectomy but attacks of pain continued. The patient was subsequently operated upon. No calculi were found in the ducts but "upon passing the hand upward toward the dome of the liver on the right side, a large calculus was found embedded in the liver substance about four inches from the free border of the liver." Hawkes performed this operation in two stages, introducing sterile gauze at the first operation to form adhesions. At second operation, four days later, the liver substance was incised and the calculi "dug out with the index finger from an indurated mass of surrounding tissue." Three large calculi were removed. There was considerable hæmorrhage which was checked by tamponade. In Doctor Owen's case the cautery was used for the liver incision and no worrisome hæmorrhage occurred. Hawkes suggests the advisability of palpating the liver surface during operation in cases diagnosed as cholelithiasis where the findings in the region of the gall-bladder and ducts do not seem sufficient to account for the symptoms present. He further states that it "seems possible that liver abscesses of unknown etiology have arisen from such cause." Vachell and Stevens<sup>5</sup> reported a fatal case of intrahepatic calculus associated with multiple abscesses of the liver and subdiaphragmatic abscess. The gall-bladder in this case was normal in size and contained no calculi. Jaundice was not present until nineteen days before death. Chemical analysis of these calculi showed a predominance of calcium bilirubin. The culture from the abscesses of the liver showed *Bacillus coli* and whereas the patient had typhoid a number of years before, the typhoid bacillus was not found.

## MULTIPLE NEURITIS AFTER INJECTION OF TETANUS ANTITOXIN

Again in Draper's case *ibid* occurring on the service of Dr Arthur Newlin, at the Pennsylvania Hospital, there was no jaundice present and no local pain or tenderness. This case was not operated upon. At autopsy there were found one stone half the size of an egg, and a large intrahepatic stone with abscess of the liver. Lewisohn<sup>10</sup> reported a case of intrahepatic stone formation, there being several stones in the liver passages, one rupturing through the surface of the liver and causing general peritonitis. Jacobson<sup>11</sup> suggests that, in many secondary operations performed on cases of gall-bladder disease when stone is found in the common duct at the second operation, the apparent recurrence of the stone, which the surgeon at the time thinks was overlooked at the first operation, is actually an intrahepatic calculus which may have been present at the first operation but has descended to the common duct subsequent to the preliminary operative procedure. Weber<sup>12</sup> reported a fatal case of intrahepatic calculi. The case was operated upon for calculous cholecystitis and the gall-bladder was removed. The patient died three days after operation and at post-mortem there were found unrecognized intrahepatic calculi. He further emphasizes the fact that in intrahepatic calculi, though the hepatic duct actually appears to be blocked, jaundice may be variable in degree or even absent. McArthur<sup>13</sup> reported a fatal case of intrahepatic stone associated with stone in the common duct. There were no stones in the gall-bladder. McArthur discusses at length the etiology of calculous cholecystitis and intrahepatic calculi and reaches the following conclusions:

- 1 All gall-stones do not originate in the gall-bladder.
- 2 The origin of cholesterol stones is probably in the gall-bladder with subsequent growths either in the gall-bladder or ducts where they may lodge.
- 3 Bilirubin calcium is the constituent of the smaller intrahepatic duct stones.
- 4 Calculi in immense numbers may have existed for months in the ducts without producing a symptom.
- 5 The surgeon need not reproach himself too much if there be recurrence of the symptoms after common duct drainage.

This case is reported to emphasize three points:

- 1 The method of approach through the dome of the liver to remove the intrahepatic calculus.
- 2 The use of the cautery for the liver incision which minimized hæmorrhage.
- 3 The instance of post-operative hyperglycæmia due either to temporary chemical change in the pancreas or trauma to the pancreas inflicted at the time of operation. This temporary hyperglycæmia has been noted in a number of our gall-bladder operations.

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## MULTIPLE NEURITIS FOLLOWING PROPHYLACTIC INJECTION OF TETANUS ANTITOXIN

DR HUBLEY R. OWEN presented a man twenty-eight years of age, who, on December 18, 1930, received a punctured wound of the right foot. On

the following day 1,500 units of tetanus antitoxin were administered into the subcutaneous tissues of the anterior abdominal wall. On December 25 he developed a severe generalized urticarial reaction for which he received an injection of adrenalin. On December 28 he was awakened during the night with very severe pains in the neck, more severe on the right side pains in both shoulders, hands, forearms and in the intrascapular areas. He could not move his fingers or wrists and both upper extremities were weak. His hands and forearms felt as though they were swollen. The pain, which continued until the end of the first week in January, was associated with numbness and tingling in the hands and forearms.

January 5 the following findings were noted. The power in the left upper extremity was normal, excepting for slight weakness of the hand grasp. There was marked weakness in the grip of the right hand, and about 70 per cent loss of power in the extensors of the wrist. He complained of very severe pain in the neck, shoulders, intrascapular areas and both arms. There was tenderness over the muscles of the right side of the neck, the axilla and over all the nerve trunks in arms and forearms. Extreme abduction of the arm caused severe pain. No objective impairment of sensation could be elicited, but subjectively there were numbness and tingling of the right hand and forearm. Tenderness, not as severe in character, was noted over the nerve trunks of the left arm. Power of both deltoids normal. There was definite weakness of the biceps and triceps muscles of the right arm. The left biceps and triceps muscles were normal. The bicipital and tricipital reflexes could not be obtained on the right side, but were normal on the left.

The above symptoms improved slowly. On January 9 he was able to resume light duty. By January 19 he had recovered sufficiently to return to active duty. Recent examination reveals that the power in both arms and hands is normal and equal. On lifting weights there is a moderate winging of both scapulæ. The patient states that he does not appear to have the same strength in his arms and hands as he had prior to the attack of neuritis.

The speaker remarked that cases of multiple neuritis following the prophylactic injection of tetanus antitoxin have been previously reported. The first report in the literature is by Thaon.<sup>1</sup> Approximately twenty cases have been reported. This manifestation of allergy is a comparatively rare one. Braunlich<sup>2</sup> cautions against the use of fresh tetanus antitoxin, stating that as a result of its use, serum reaction occurs more frequently and is more severe. Multiple neuritis may follow prophylactic injection of tetanus antitoxin or other sera. The prophylactic or therapeutic use of serum must be administered with the realization of this fact. None of the present indications for the administration of sera should be ignored because of the comparatively rare complication of neuritis. More careful testing for sensitization is advisable in the use of anti-sera to avoid this and all other unpleasant complications of serum therapy.

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## INFLAMMATORY REACTION OF THE LOOPS

In answer to the question whether the patient had ever received any injections of serum before, the reply was made that he had had an injection of anti-tetanic serum for a punctured wound about eight years ago. The speaker added that apparently those cases that are sensitized to serum are those in which this condition is more prone to develop. Prophylactic injection of toxin-antitoxin for diphtheria immunization has apparently been enough to sensitize many individuals to reactions of this sort.

DR HUBLEY R. OWEN stated that in the police and fire departments of Philadelphia, it was necessary to give approximately three hundred prophylactic doses of tetanus antitoxin each year. In twenty-four years, this is the first case of neuritis which he had seen following the administration of antitoxin.

### INFLAMMATORY REACTION OF THE LOOPS FOLLOWING GASTROENTEROSTOMY

DR FREDERICK A. BOTHE presented two cases developing high intestinal obstruction following gastroenterostomy for duodenal ulcer. Secondary operations were performed and in each patient an inflammatory process was found in both the proximal and distal loops of the gastroenterostomy, with associated obstruction of the stoma.

The first case, a male, fifty-six years of age, was admitted to the Presbyterian Hospital, August 20, 1930, with a typical history of duodenal ulcer of fifteen years' duration. Twenty-four hours before admission he had a large gastric hæmorrhage, and passed several tarry stools. On admission, the hæmoglobin was 62 per cent, red blood cells 3,600,000, and white blood cells 7,600. The routine management for the bleeding ulcer was instituted. On the fifth day the patient's general condition had improved, there was no evidence of bleeding and an exploratory laparotomy was performed with the pre-operative diagnosis of bleeding duodenal ulcer. At the operation a large duodenal ulcer was found in the first portion of the duodenum on the anterior wall. This was excised by the cautery, sutured, and the suture line was covered with a portion of the lesser omentum. A posterior gastroenterostomy and appendectomy were performed and at the conclusion of the operation, a blood transfusion of 300 cubic centimetres was given. The immediate post-operative reaction was satisfactory. Water was taken without any evidence of retention until the fourth day when fullness in the epigastrium and hiccoughs developed and the temperature rose to 101°F. Forty ounces of bile-stained fluid were recovered by gastric lavage. Blood chemistry studies showed a slight fall in the blood chlorides and an elevation of the blood urea nitrogen. The stomach was repeatedly lavaged with a Jutte tube and 1,000 cubic centimetres of 5 per cent glucose in normal salt solution was administered intravenously twice daily. Although there was slight general improvement in the next thirty-six hours, the retention persisted and an exploratory operation was performed. Both the proximal and distal loops of the gastroenterostomy were markedly inflamed and the stoma was entirely closed. The inflammatory reaction extended down the proximal loop to within 2 inches of the ligament of Treitz and in the distal loop for the distance of about 5 inches. The ligament of Treitz was severed to mobilize the upper portion of the jejunum and an enteroenterostomy was made between the proximal and distal loops below the involved portions. A jejunostomy of the Witzel type was then performed. At the termination of the operation a blood transfusion of 300 cubic centimetres was given. Repeated gastric lavage and intravenous injections of glucose and salt solu-

tion were continued and in addition 5 per cent glucose in normal salt solution was administered through the jejunostomy tube by the Murphy drip. The patient's condition did not change very much in twenty-four hours, so a Jutte tube was left in the stomach and every two hours the gastric contents were aspirated and introduced into the jejunum through the jejunostomy tube. This procedure benefited the patient symptomatically and produced a definite improvement in the degree of dehydration in twenty-four hours. Charcoal was placed in the stomach after the aspiration at various intervals, but no trace of it could be found in the jejunum until seventy-two hours after the operation. On the fourth day the temperature became normal, and on the fifth day fluids passed through the stomach readily. Oral feedings were started and gradually increased, intravenous injections of glucose and salt solution were discontinued on the sixth day, feeding through the jejunostomy tube was discontinued on the eighth day, and the jejunostomy tube was removed on the fourteenth day. Subsequently, the convalescence was uneventful. Since his discharge from the Hospital, the patient has gained twenty-two pounds in weight and is symptom-free.

The second case, a man, forty-one years of age, was admitted to the Presbyterian Hospital April 18, 1927, under the care of Doctor Pfeiffer. He had an eight-year history typical of duodenal ulcer and the X-ray was positive for this lesion. April 22, 1927, a laparotomy was performed, a duodenal ulcer was found, and a gastroenterostomy and appendectomy were performed. The patient's immediate post-operative reaction was satisfactory and he was able to take soft diet with no discomfort. On the eighth day symptoms of gastric retention developed with an elevation of the temperature of  $100\frac{1}{5}^{\circ}\text{F}$ . Gastric lavage was performed and glucose and saline were administered intravenously. Blood chemistry studies showed a more severe alkalosis than was found in the first patient. The  $\text{CO}_2$  was 85 volumes per cent, the blood chlorides were 208 and the blood urea nitrogen, 26 per cubic metres of blood. The patient's condition became progressively worse and the gastroenterostomy was explored on the twelfth day. Both the proximal and distal loops were greatly inflamed, the stoma was closed and the distal loop was collapsed beyond the area of inflammation. An enteroenterostomy was made between the two loops. Gastric lavage and intravenous medications were continued. There was slight improvement for twenty-four hours, but the patient's progress was not satisfactory. On the second day a jejunostomy was performed with a marked relief of symptoms in twenty-four hours. Forty-eight hours after the jejunostomy the patient's temperature fell to normal and at the end of four days fluids passed through the stomach into the jejunum. The diet was gradually increased until solid food was taken with no evidence of retention. Three weeks after the jejunostomy, when the patient had completely recovered from the gastric retention, an upper respiratory infection occurred which was complicated by multiple abscesses of the lung and empyema which was ultimately responsible for his death, two and one-half months after the original operation. The respiratory condition is mentioned briefly as before the onset of this complication, the inflammatory reaction of the loops of the gastroenterostomy had subsided and the patient was well on the road to recovery.

These cases are presented for two reasons. First, inflammation of the loops was the cause of gastric retention following gastroenterostomy, and secondly, the jejunostomy placed the inflamed area at rest, permitting the inflammation to subside and thereby relieving the obstruction.

The etiology of the inflammatory process could not be determined. Both gastroenterostomies were performed in the routine manner and no inflammation was present at the time of the primary operation. There were several findings in the post-operative course which were considered of significance in arriving at this diagnosis. First, the onset of the symptoms of gastric retention developed suddenly in patients who were apparently taking oral feedings very satisfactorily, and secondly, there was a simultaneous elevation of the temperature. The sudden onset of symptoms may be explained by the fact that the inflammatory reaction had gradually encroached upon the lumen of the stoma, and it was not until the stoma was completely closed that the gastric retention occurred. The elevation of temperature is a valuable sign when there are no other physical findings to account for it.

Doubtless cases occur in which the inflammatory reaction is not severe enough to produce a complete obstruction. Possibly some cases which do not take fluids as well as usual, following gastroenterostomy, would fall into the milder group. A case which the speaker believed to be of this nature, occurred in the service of Doctor Speese, at the Presbyterian Hospital, in 1927. This patient did not have complete retention, but the gastroenterostomy did not relieve his symptoms. X-ray studies made two years after operation were suggestive of marginal ulcer. An exploratory operation revealed no evidence of marginal ulcer, as suggested by the X-ray, but the loops of the gastroenterostomy were bound down to the transverse mesocolon by dense adhesions. The stoma was found to be patulous and would admit two fingers. The adhesions were freed and the raw surface thereby produced, covered with omental grafts. Since the second operation the patient has had no further symptoms. This case strongly suggests a mild type of inflammatory reaction and with the subsidence of the inflammation, the loops became adherent to the transverse mesocolon in such a way as to produce mechanical interference to the proper functioning of the gastroenterostomy.

Jejunostomy has been shown to be of great value in inflammatory lesions of the stomach and upper gastro-intestinal tract, and in these two cases apparently it was the most important procedure in the relief of the obstruction.

Balfour has called attention to the value of jejunostomy in the treatment of apparently irremovable lesions of the stomach, complicated by inflammation. He has observed a number of cases with complete disappearance of symptoms after a few weeks of feeding through the jejunostomy tube and without recurrence following removal of the tube. The length of time for the tube feedings will depend on the roentgenologic evidence as to what changes are taking place in the lesion. If supplementary oral feedings become advisable, they should be based on a strict antiulcer regime. It is possible in some cases to perform secondary operations on the patients after some weeks, and excise the lesion when the inflammation has subsided. He reports a case operated upon in October, 1927, for a marginal ulcer following partial gastric resection. The ulcer had perforated onto the diaphragm and there was an extensive inflammatory process around it. A huge crater could be identified on the anterior part of the anastomosis. Owing to the great risk and technical

difficulties of major operative interference, a jejunostomy was performed. The patient had relief from pain in eight days, the jejunostomy tube was left in place for six months and during that time no food was taken by mouth. Eight months after the operation the patient returned symptom-free, all evidence of the lesion had disappeared and the X-ray was negative.

DR DAMON B PREIFFER said that since the standardization of the technic of gastroenterostomy has been so well placed before the profession by many surgeons, notably Moynihan, we have become accustomed to think little of what was formerly called vicious circle. The physiologic gastroenterostomy makes it very much simpler for the contents of the stomach to enter the jejunum rather than go down to the proximal loop. These two cases show that there is a type of obstruction which is not a simple mechanical one but which is due to adynamic ileus. The speaker has seen a somewhat similar condition in the colon in which the bowel had lost its elasticity. One sees it most frequently in the late stages of ulcerative colitis. The physiologic block is not due to any actual obstruction but to the inflammatory ileus. He would hesitate very much to delay operation in cases showing marked gastric retention after gastroenterostomy, hoping it would disappear. It might disappear but the proper thing to do is to explore.

DR EDWARD T CROSSAN said that Doctor Bothe states that the gastroenterostomy was done in the usual manner. He would like to know whether the "usual manner" means that there were three layers of sutures posteriorly, or whether two layers were used. He would also like to know whether the opening in the transverse mesocolon was sutured close to the stoma. It would appear that if three layers of suture are used posteriorly, and in addition to this the rent in the mesocolon be sutured close to the stoma, there is sufficient irritation from the foreign bodies to cause an inflammatory reaction such as described in these cases. The speaker agrees with Doctor Pfeiffer that jejunostomy should clear up cases of inflammatory ileus.

DR GEORGE P MULLER remarked that operative interference was often unwisely postponed in the hope that obstructive symptoms would be relieved. This practice occasionally results in the neglect of a patient suffering from severe mechanical obstruction. The speaker, however, recalled one patient whom he had ordered prepared for re-operation when it was discovered that there was a marked alkalosis. Large quantities of hypertonic saline and glucose solution were given and in twenty-four hours the clinical picture had completely changed. Doctor Muller, therefore, advocates serious consideration of the chemical state of affairs and if treatment along these lines fails to give relief, operation should not be delayed. In certain cases infection from the stomach may be carried to the suture line and thus produce an inflammatory reaction in the stoma which will prevent it from functioning.

DR FREDERICK A BOTHE said that he used two rows of sutures and sutured the mesocolon about two and one-half inches from the anastomosis.

## AVERTIN ANÆSTHESIA FROM THE SURGEON'S STANDPOINT

### PENETRATING WOUNDS OF THE ABDOMEN

DR ARTHUR E BILLINGS and DR ADOLPH WALKLING read a paper with the above title

DR CHARLES F NASSAU remarked that there is one thing that he has missed in Doctor Billings' paper and that is the relationship between the result and the calibre of the bullet. Over a good many years he had the opportunity to operate upon gunshot wounds of the abdomen, not many stab wounds. With but two exceptions he has never seen anybody shot by a 38-calibre bullet get well. Those shot with 22- and 32-calibre bullets make almost uninterrupted recoveries where there is not too much irreparable damage done. He had under his observation one 38-calibre wound get well and one wound from a 41 Swiss pistol where the bullet was never found. He thinks it would be interesting if there were some way in which Doctor Billings could look up the calibre of the bullets that caused the injuries and show whether there is any basis in his cases for Doctor Nassau's belief.

DR ARTHUR E BILLINGS replied that he had thought of investigating that question but the calibre of the bullet is so seldom known in most cases that he was unable to get enough histories to make it of any value.

### AVERTIN ANÆSTHESIA FROM THE ANÆSTHETIST'S STANDPOINT

DR JOSEPH KREISELMAN (by invitation) read a paper with the above title for which see page 885.

### AVERTIN ANÆSTHESIA FROM THE SURGEON'S STANDPOINT

DR CHARLES S WHITE (by invitation) read a paper with the above title for which see page 888.

DR CHARLES H FRAZIER said that the performance of cranial operations is different from those of the abdominal or general surgeons in that relaxation is not a very important factor. In cranial exploration under local anæsthesia alone he found that the method was entirely satisfactory in most respects, that is, in so far as being able to operate without pain. Cranial explorations are long drawn out affairs and patients are often on the table for two hours. There is a tendency for the pulse rate to become high and the blood pressure to fall. The addition of small amounts of ether improved the blood pressure and the irregularity of pulse would disappear. Doctor Grant and the speaker have tried avertin in a number of cases and in every respect it seems satisfactory. His anæsthetist experimented as to the dosage, it being desirable, of course, to use a minimum dose. She started with 80 milligrams and found it a little too much, there being a tendency to cyanosis and the early fall in blood pressure. At present she has found that 60 milligrams is quite sufficient. The administration is simple. The patient is given a colonic irrigation about one hour before being brought to the anæsthetizing room and fifteen minutes before that one-half grain of codein, followed in a few minutes by the avertin. Occasionally there is a fall in blood pressure within fifteen to twenty minutes, but it usually responds of itself. Occasionally he gives one-half an ampoule



of pituitrin Doctor Frazier's experience with this dosage has been satisfactory and gave no cause for alarm

DR GEORGE P MULLER said he saw the publication of Doctor White's previous paper He had begun the use of avertin and during the winter had used it in forty-three cases, of which about half were goitre Forty were successful from the standpoint of anæsthesia Blood pressures usually fell for a short period but not nearly so much as occurred in spinal anæsthesia Nitrous oxide gas was used as a secondary anæsthesia and the patients required but little of it No patient showed any complication from the avertin

DR EDWARD W BEACH said that he had used avertin, not so much as the essayists, but had found it very satisfactory There is a drop in pulse pressure early in the anæsthesia The reaction is very quick Cyanosis has not given trouble although he always has a tank of CO<sub>2</sub> and oxygen present He varies the dosage according to the operation, in major abdominal work using the larger doses The advantage of nitrous oxide as the supplemental anæsthetic is that one maintains a high percentage of oxygen which is desirable as it maintains a higher metabolic rate In other words, one can conduct a section on a 50-50 instead of an 80-20 mixture Doctor Beach thinks avertin possibly impairs the action of the kidneys at first but only temporary It certainly is an approach toward the ideal, and the patients are all well pleased

DR CHARLES S WHITE, said that he believed the proper way to use avertin is to begin with a small dose, 60 milligrams for instance, and gradually increase it in various cases until the proper dosage is reached This will be 80-90 milligrams per kilo of body weight He did considerable laboratory work in connection with avertin, but did not go into the matter of dosage because this has already been well worked out by the Germans He believes avertin is a distinct advance in anæsthesia and is well worth trying For a long time he has been considering the anæsthetic from a surgeon's standpoint, in his opinion it is now time to give the patient due consideration

DR JOSEPH KREISELMAN, replying to questions, said that he was not prepared to make a comparison between amytal and avertin He had never used the former It is a little difficult to give a definite dosage In the beginning he used 100 milligrams almost routinely for abdominal surgery He would use 100 milligrams in a young healthy adult man now, perhaps in a young woman In an obese patient, say 160 pounds, he probably would use somewhere between 80 and 90 A recent patient who weighed about 170-180 pounds and had a blood sugar of 300 received what he estimated to be about 50-60 milligrams and there was practically no change in her blood sugar post-operatively He has never used it intravenously The speaker does not consider 80 milligrams enough for the average abdominal operation On occasions 100 milligrams is slightly exceeded The respiratory rate is decreased with the larger doses Cyanosis has not been observed in any case

# BRIEF COMMUNICATIONS

## PREPARING POUCHES OF THE FUNDUS OF THE STOMACH

IN PREPARING pouches of the fundus of the stomach large enough to obtain a satisfactory quantity of gastric juice, difficulty is experienced with excoriation of the skin and abdominal wall surrounding the fistula, even if antacids are used and continuous drainage of secretions is instituted. Mann and Bollman<sup>1</sup> have described a method of preparing intestinal fistulas which we have modified in preparing such pouches.

Under ether anæsthesia, and strictly aseptic technic, the abdomen is opened through a median-line incision from just below the xyphoid process to the umbilicus. A segment of the terminal ileum from 10 to 15 centimetres long

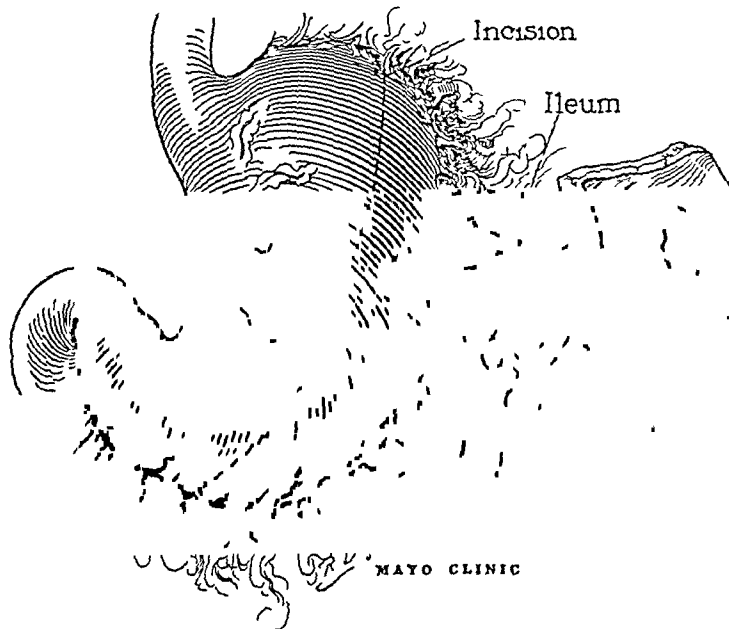


FIG 1.—First stage of fundus pouch

is resected, its blood supply being preserved. Intestinal continuity is reestablished by end-to-end suture. The distal end of the resected loop is sutured to an opening made high along the greater curvature of the stomach, whose diameter is somewhat smaller than that of the intestinal loop. The proximal end is brought out through a stab wound made in the abdominal wall under the left costal margin in the nipple line and fixed to the fascia and skin with several interrupted sutures (Fig 1). The abdomen is closed in layers. After healing is completed, usually in from twelve to fourteen days, the abdomen is reopened through the same incision, and a portion of the stomach drained by the fistula in the intestinal loop is made into an isolated pouch of either the Pavlov or Heidenhain type (Fig 2).

The peristaltic wave in the loop of bowel is away from the abdominal wall, which tends to return secretions to the pouch, giving it a valve-like action. If

there is an overflow of secretion so that it reaches the skin, it has passed over 10 to 15 centimetres of intestinal mucosa, and excoriation is reduced to a minimum. In several months of observation we have not seen leakage from the fistulas, thus raising the question of absorption of the acid by either the stomach or more probably the ileum mucosa. We hope to answer this question in the near future. The two-stage procedure enables the fistulous opening to become well healed before any appreciable amounts of acid secretions pass over it.

The animals used in such experiments do not require special care. At any time about 20 cubic centimetres of gastric juice can be obtained, the amount depending on the size of the pouch. The small amount of secretion of the loop of intestine returning to the pouch can be readily prevented, when pure

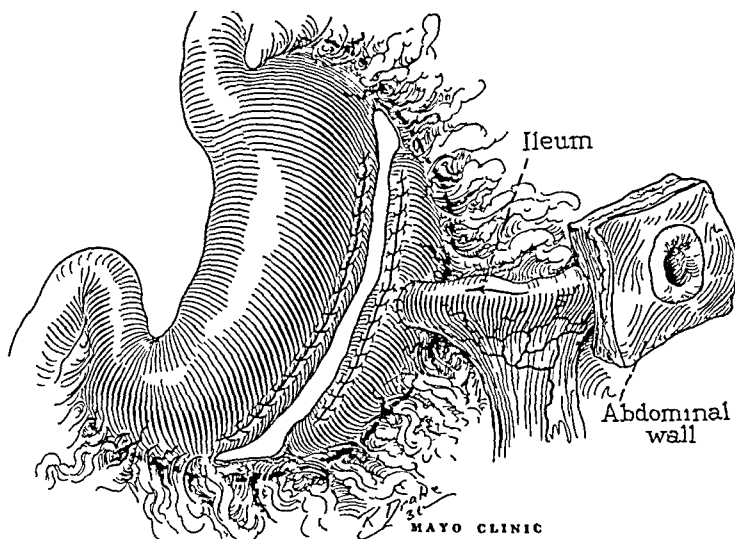


FIG 2—Second stage of fundus pouch

gastric juice is desired, by inserting a Pezzer mushroom catheter well within the pouch and exerting enough traction on it to impinge the mushroom against the contracted line of the gastro-ileal anastomosis. Acid values are in every way comparable to those obtained in dogs with a Pavlov pouch; excoriation and continuous care are eliminated and sufficient volume of secretion can be obtained for practically all experimental purposes.

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## CALIBRATED SURGICAL DRAINS

WITH the use of conventional drainage material such as rubber tubing, rubber dam and cigarette drains, the post-operative care of patients with surgically drained lesions is sometimes complicated, by virtue of the fact that the surgeon does not at all times know the exact depth to which the drain is introduced into the operative wound

Very often in hospital ward practice because of the fact that several physicians may dress the same patient and shorten drains from day to day, it is impossible to know the exact length of the drain at a given time, without the troublesome and time-consuming procedure of frequently consulting the clinical chart. Even then, the length of the drain may still be in doubt, unless the amount which it has been shortened at each dressing has been accurately recorded

The reverse of this situation obtains, when the surgeon desires to introduce a drain, at the time of operation, into a cavity for a specified distance. Being unable to readily ascertain the length of that portion of the drain which he has just introduced into the wound, he must next withdraw it to approximate its length, and then re-introduce it for the desired distance. The importance of knowing the exact depth to which the drain is introduced—for instance, into a brain abscess cavity or into a pulmonary or pleural cavity, where impingement of the end of the drain on various important structures is to be avoided—is obvious. Similarly, knowing the depth to which a tube is introduced through the abdominal wall into the peritoneal cavity or into a hollow viscus such as the gall-bladder, the common bile-duct, stomach, intestine, ureter, or bladder, makes for precision and allows one to note immediately whether the tube has been displaced or has become accidentally partially withdrawn, at any time after introduction

Many surgeons use cigarette drains for primary drainage and replace these drains in the course of a few days with rubber tubes. By knowing the exact length of each drain beforehand, the process of replacement of the cigarette drain by the rubber tube is simplified and is devoid of the trauma which, of necessity, occurs when one attempts to force a drain to the very bottom of an existing sinus tract of uncertain depth

In an attempt to make for greater accuracy and precision, and to obviate some of the difficulties described above, we endeavored by several methods to calibrate numerous lengths of rubber drainage tubing. Various indelible inks and paints proved fairly satisfactory until the tubes were boiled. After numerous trials, the results of which were unsatisfactory, we conceived the idea of having the calibrations printed on a rubber strip, which in turn could be affixed to the drainage material. In cooperation with Mr. John R. Foley, of the Orrsell Company of New York City, we finally improved on this plan, and devised a new type of calibrated drainage material which has proven highly satisfactory during the past four months of use

The calibrations, which are one-half centimetre apart, are vulcanized

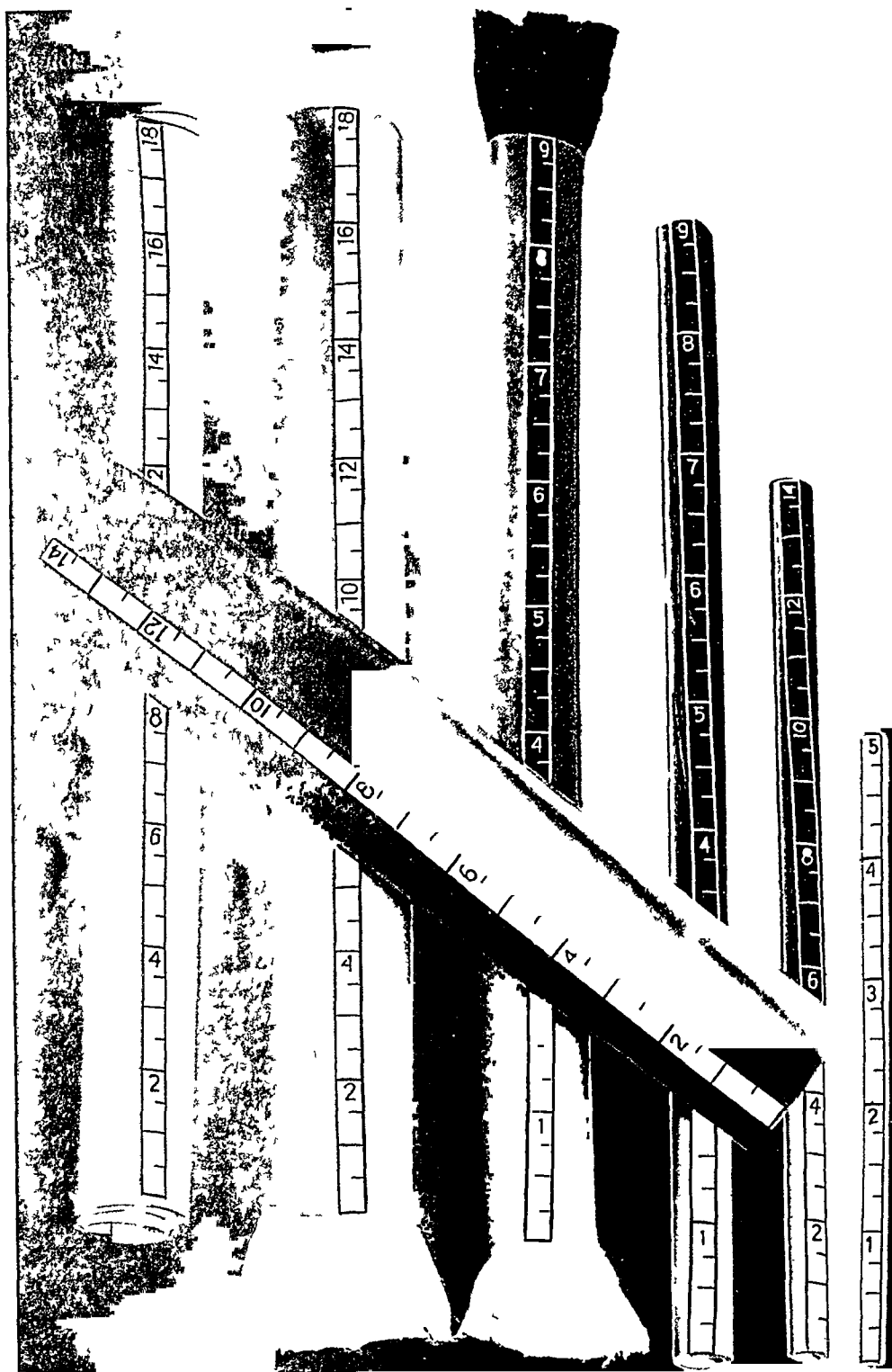


FIG 1—(1) Rubber tubes (various calibres) calibrated in centimetres and inches (2) Cigarette drains calibrated in centimetres and inches (3) Rubber dam calibrated in centimetres (4) Penrose tube calibrated in centimetres

directly on a very thin strip of rubber four millimetres wide which constitutes the background (Fig 1) This calibrated rubber strip in turn is vulcanized and processed directly to the rubber tube, dam, or Penrose tube as the case may be The entire unit is then coated with a very thin layer of rubber which imparts to it a smooth finish Thus the calibrations which are now an integral part of the drain are of permanent character, and do not fade even when exposed to corrosive discharges or subjected to repeated boiling or chemical sterilization We have had the calibrations placed on strips of white, red, yellow and green rubber, thus providing contrastingly colored backgrounds

The value of using drains marked with distinctive colors is obvious when the necessity arises for introducing through a single wound several drains into different parts of the same cavity By noting the colors of the calibrated strips on the drains introduced into the different areas at the time of operation, it becomes unnecessary to designate them with external markers, and thus another troublesome and time-consuming feature is obviated

It is common practice in many hospital operating rooms to supply to the surgeon drainage material cut into twelve-inch lengths The operator selects the type of drain he desires, cuts off the required length, and discards the remainder A considerable waste of material thus occurs In the interests of economy, we have had our drains supplied to us in ten-, fifteen-, and twenty-centimetre lengths and have found that the saving effected thereby has enabled us to use the calibrated material at only very slight increase in cost over that of the ordinary type

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## A MODIFICATION OF THE STEWART SUTURE

HOWES, SOOY and HARVEY showed that if the edges of wounds in the entire thickness of skin were immediately approximated with sutures so as to bring the entire depth in accurate apposition, the epithelium bridges the surface so rapidly that epidermization does not appear as a factor They also showed that there is an initial quiescent or "lag" period (Robertson) in the healing process represented by the time up to the fifth day The strength during this period is that of the holding power of the suture The tensile strength of a healing wound is a function of the fibroplastic process which takes place in the phase of fibroplasia The maximal strength of the wound being attained by the latter process in from ten to fourteen days, the suture to be described tends to give skin wounds the optimum physiologic requirements as described above for perfect healing, besides the purely cosmetic results obtained

Fig 1 shows the very useful and usual suture (Stewart's) used in closing up skin wounds

## BRIEF COMMUNICATIONS

Fig 2 shows its modification, and might be termed a subcuticular type of Stewart suture. The suture is introduced by a straight cutting needle at point (A) on side of assistant to point (B), similar to the usual Stewart stitch, going to deeper layers of skin and subcutaneous tissues to obliterate any dead space

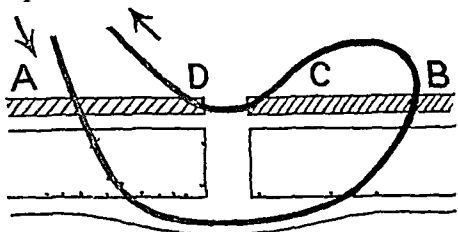


FIG 1

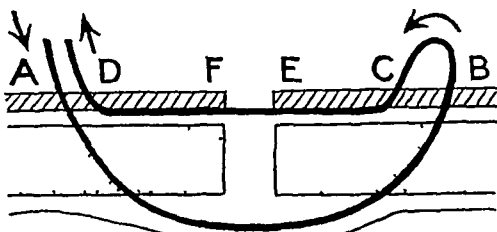


FIG 2

Instead of going to point (C) Fig 1, the needle is then directed to point (C) Fig 2, one-quarter of an inch medial to point (B) and allowed to pass directly under the skin and emerge at point (E)—edge of incision



FIG 3—Herniotomy wound Ninth day post operative upon removal of above type of suture. Note only three sutures used, hair-line scar, absence of cross marks

Then the needle is passed subcuticularly from point (F) to (D), the latter emerging one-quarter of an inch medial to point (A)

The suture is then tied, giving a perfect hair-line wound approximation similar to a subcuticular suture

This suture can readily be removed by cutting either end and pulling out

The suture as used on clean cases at the Bellevue Hospital has proved very satisfactory. The suture is easily applied, gives an excellent hair-line approximation, avoids cross wound cutting and scarring, and is easily removed

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(CHIRURGIA DEL DOLORE) BY PROF IGNAZIO SCALONE 8 vo , pp xvi-256  
Ulrico Hoepli, Milano, 1931

Surgery of the Peripheral Innervation of the Sympathetic System is the title of a monograph written by Scalone, of Milano, which carries as subtitle, in red type about twice the size of the title, "Chirurgia del Dolore" (Surgery of Pain)

It would not be fair to offer a criticism of such an excellent monograph without remarking that both the title and the subtitle, especially the latter, to which the large red type used calls the attention of the reader, are misleading. The monograph does not truly deal with "The Surgery of Pain" or with the surgery of the innervation of the sympathetic system, it deals only with certain special phases of these subjects, to which Scalone has devoted a great deal of personal consideration. Thus, for instance, no mention is made of trigeminal neuralgia, which causes the most intense and often most irremediable of pain.

These limitations stated, nothing but praise should go to Scalone for his conscientious, intelligent and honest endeavor. The monograph was selected by the Reale Istituto Veneto di Scienze, Lettere ed Arti, as deserving the Munich prize among monographs dealing with the surgery of the nervous system. The anatomy, the physiology, and the pathology of the sympathetic system are not sufficiently known to build upon such scanty knowledge practical clinical conclusions and applications.

All this is frankly stated by Scalone, who, however, gives an admirable résumé of the present-day knowledge of the anatomy, physiology and pathology of the sympathetic system. The value of this résumé is enhanced by splendid original illustrations and valuable personal considerations and investigations.

The clinical part of the work is dealt with in fifteen chapters, the most important of which are the ones referring to Scalone's original work. Thus the chapters dealing with the sympathetic innervation of the vocal cords and the ones where he illustrates the advantages of his technic of neural sympathectomy are of great interest.

Scalone contends that neural sympathectomy, in many cases, is more effectual and has a broader field than Leriche's vasa sympathectomy. He shows that many peripheral nerves carry a large number of sympathetic fibres, and that certain territories are consequently greatly benefited by neural sympathectomy, if the proper nerve is selected. He insists on thorough anatomical, physiological and pathological knowledge on the part of the surgeon who wishes to attempt to do surgery of the sympathetic system.

The histories of forty-four personal cases complete the monograph.

The uncertainty existing about the sympathetic system is plainly reflected



## BOOK REVIEWS

through every page of the monograph. This makes it really valuable. The early enthusiasm of numberless biologists and surgeons about Leriche's operation and all other procedures aiming at destroying the fibres of the sympathetic nerve, entering nerves, blood-vessels, glands, *etc*, is absent. A sober endeavor to restudy thoroughly the whole subject, beginning from its anatomical and physiological basis, without being swayed by enthusiasm or discouraged by poor results, makes Scalone's monograph most praiseworthy.

Scalone's monograph should be consulted by anyone intending to do surgery of the sympathetic system, because it relates the personal, unbiased experience of an intelligent, competent, hard-working surgeon and biologist who has devoted twenty years to the study of the subject.

ANGELO L. SORESI

UROLOGICAL ROENTGENOLOGY (Second edition revised) By HUGH A. YOUNG, M.D., AND CHARLES A. WATERS, M.D. 4 vo, cloth, pp 560. Paul B. Hoeber, New York, 1931.

The review of the first edition of this work appeared in the *ANNALS OF SURGERY*, vol LXXX, No 3, March, 1929. The remarks made then may be reiterated. A second printing of the volume necessitated at this time has given the authors an opportunity of incorporating the advances in urology made during the past two years and of revising and elaborating the previously written chapters. Thus, many new and interesting cases have been incorporated, gathered both from the literature and from recent cases in the Brady clinic.

Since the publication of the first edition, the subject of intravenous urography has been developed and a new chapter devoted to the details of its administration has been added. The discussion of the evaluation of these new methods is of definite value. A second chapter takes up the consideration of the more recent technic of arteriography and depicts graphically the delineation of the aorta and its abdominal branches in urological roentgenology. A few pages have also been added showing the clinic methods of keeping records. The new Young-Elvers phthaleinometer is also illustrated and its use described.

In all, sixty-four pages and seventy-four illustrations have been added to the original work. The general composition of the volume is most excellent and will prove of great value not only to the specialist, but to the general practitioner and surgeon as well.

JAMES T. PILCHER

### EDITORIAL ADDRESS

The office of the Editor of the *Annals of Surgery* is located at 131 St James Place, Brooklyn, New York. All contributions for publication, Books for Review, and Exchanges should be sent to this address.

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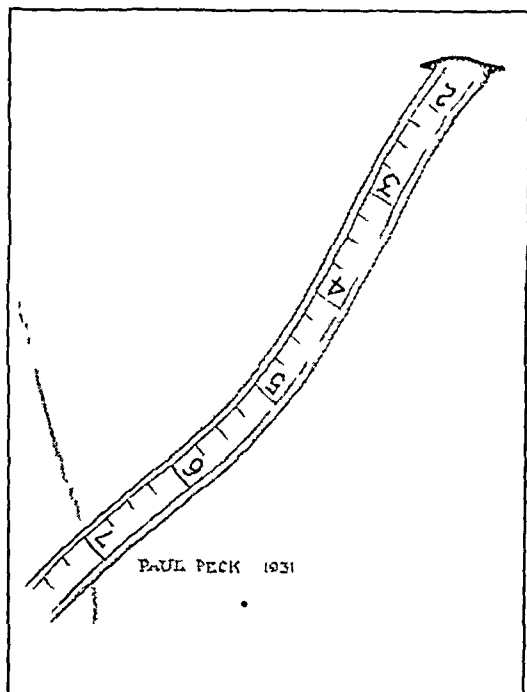


Fig 1

Figs 1 & 2 Closed Drainage in  
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Tube introduced to a point  
just within the chest)

Fig 3 Appendectomy with  
drainage thru McBurney  
incision

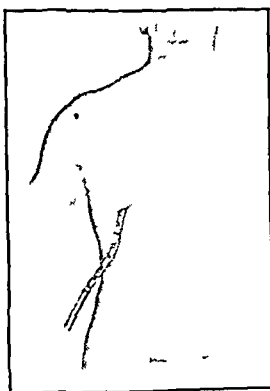


Fig 2

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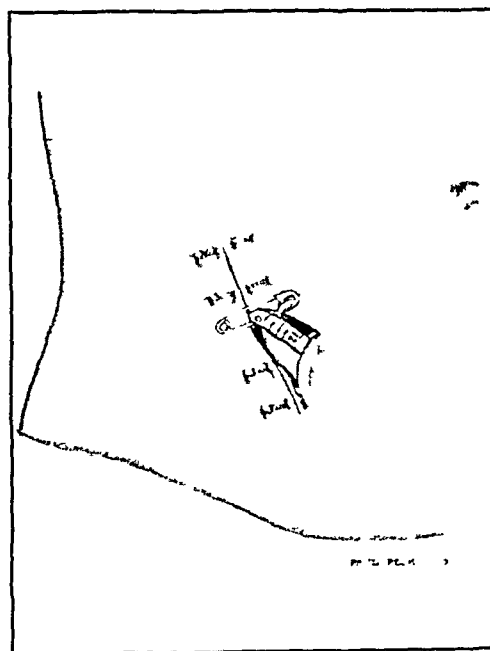


Fig 3

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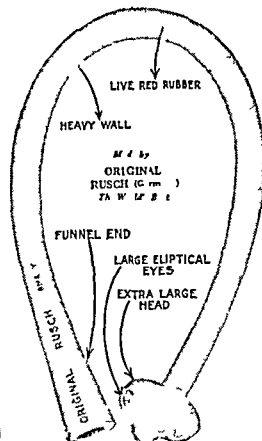
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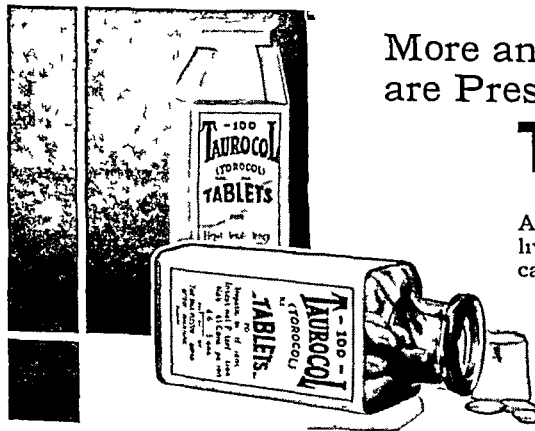
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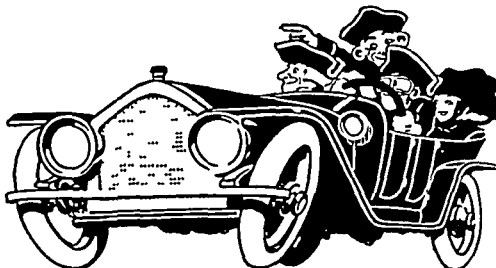
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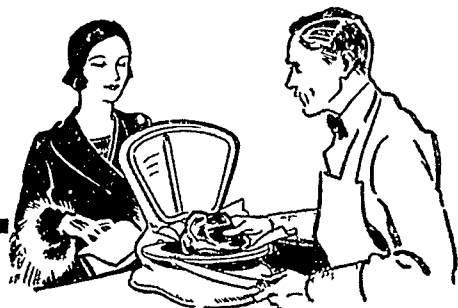
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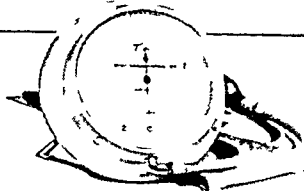
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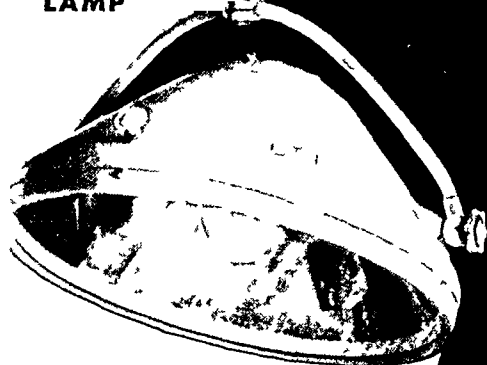
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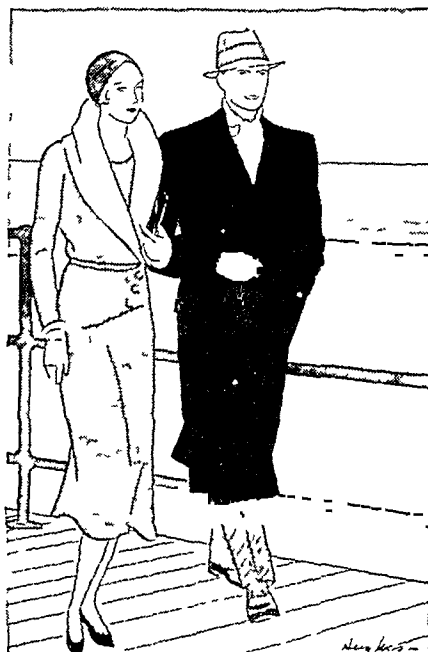


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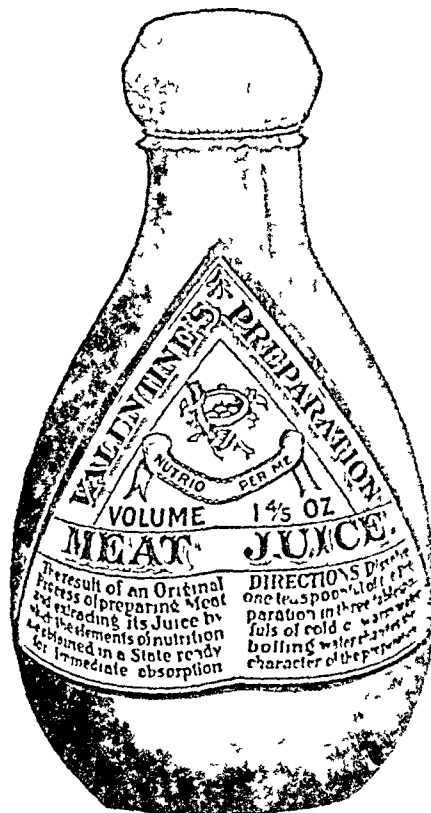
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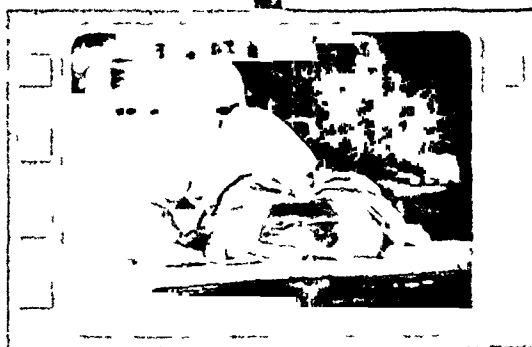
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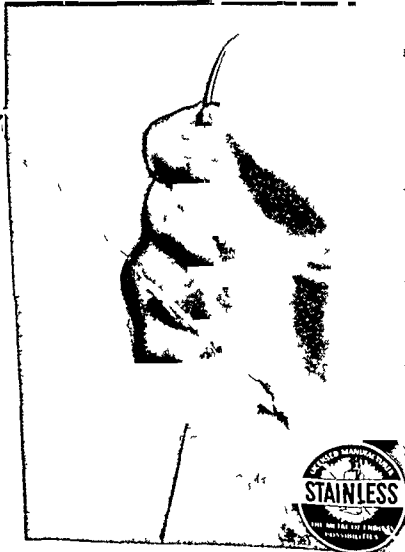
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SCOTT & BOWNE, 409 Pearl St., New York.

# ANNALS of SURGERY

A Monthly Review of  
Surgical Science and Practice

*Edited by*

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Official Publication of the American Surgical Association, of the  
New York Surgical Society and the Philadelphia Academy of Surgery

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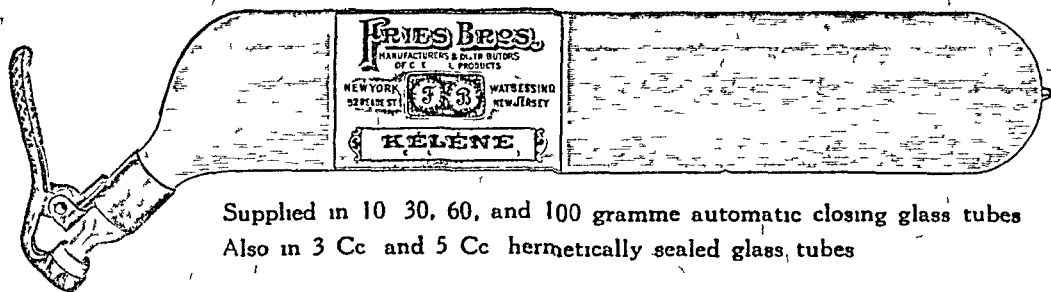
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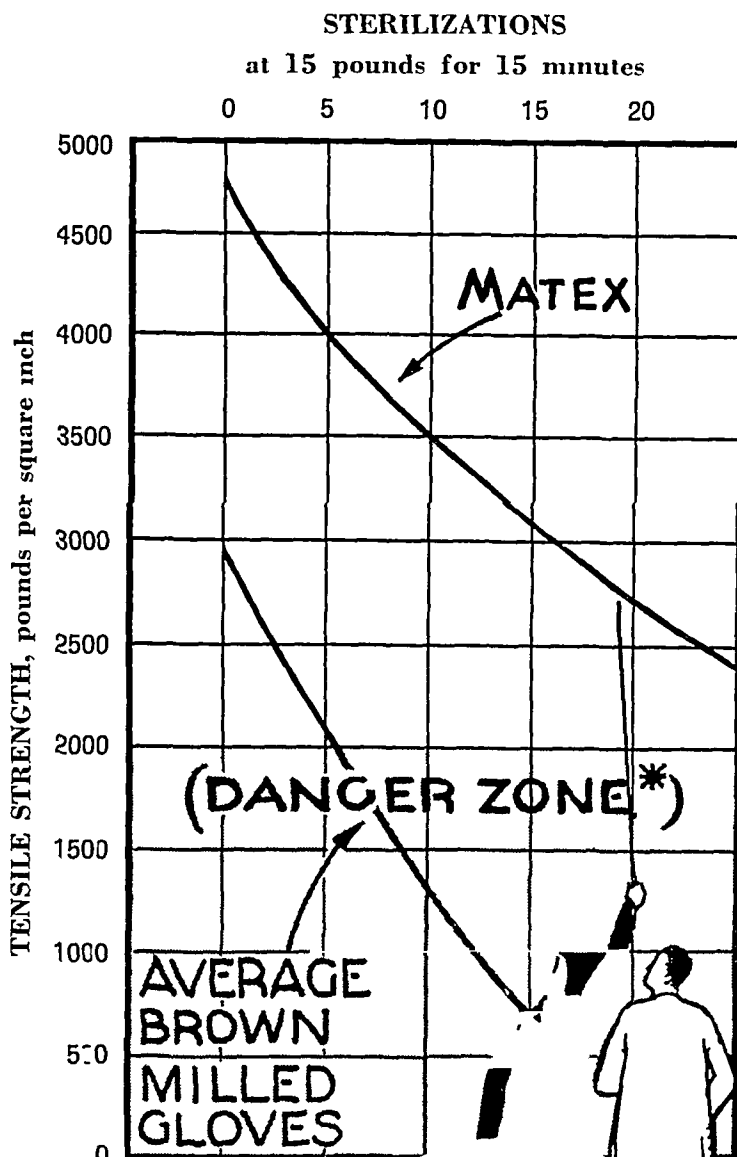
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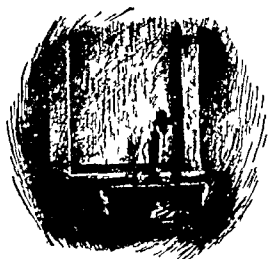
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Vol 94 - Dec - 1931 - No - 6

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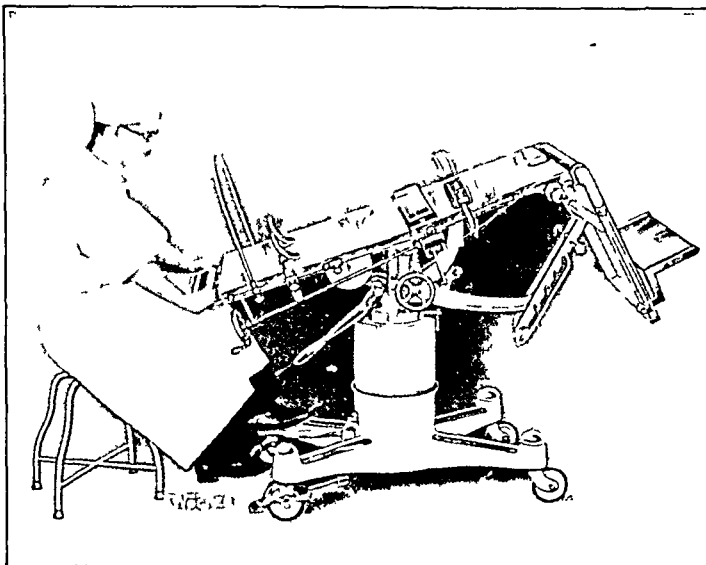
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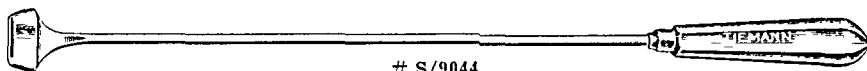
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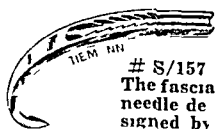


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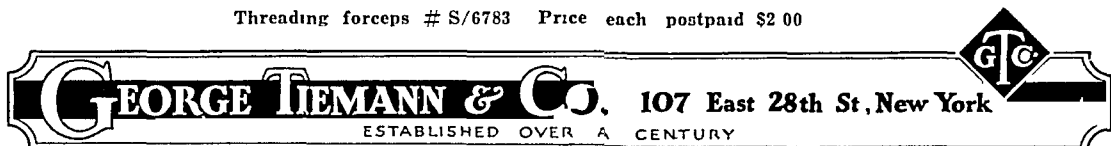
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The fascia  
needle de-  
signed by  
Dr Charles M Gratz  
Price each postpaid  
\$2 00

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The jaws are fine enough to go thru the eye of the needle and pull the suture thru.

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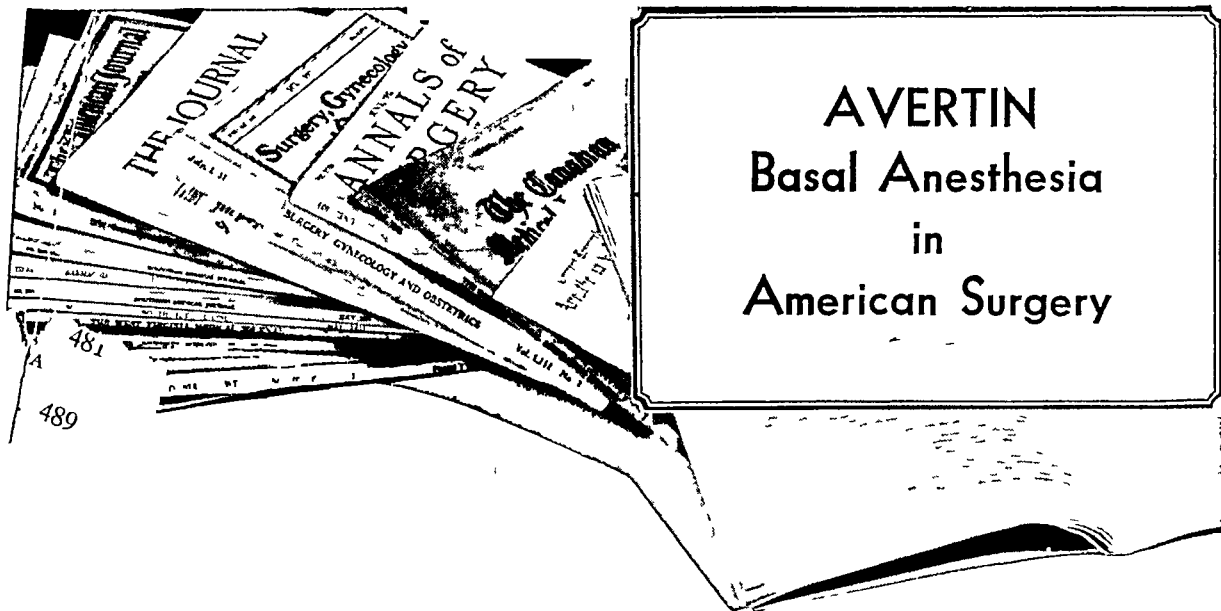
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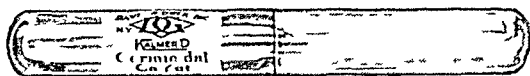
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HEAT STERILIZED

\*Also prepared in the non-boilable variety combining heat sterilization with extreme flexibility

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The boilable grade is unusually flexible for boilable catgut, the non-boilable grade is extremely flexible

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1245	20-DAY CHROMIC	1445	
1285	40-DAY CHROMIC	1485	

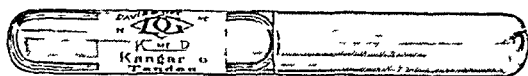
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**GERMICIDAL**, being impregnated with potassium-mercuric-iodide † Chromicized to resist absorption in fascia or in tendon for approximately thirty days The non-boilable grade is extremely flexible



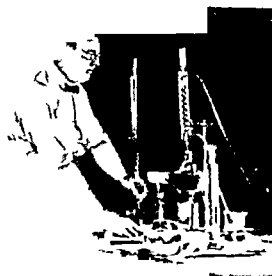
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380			

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Each tube contains one tendon

Lengths vary from 12 to 20 inches

Package of 12 tubes of a size \$3 00  
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*D&G Sutures are always found neutral under the most delicate titration tests This is one of the reasons they uniformly behave well in the tissues*

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"IDFAL FOR DERMA-CLOSURE"

**A** NON-CAPILLARY, heat sterilized suture of unusual flexibility and strength It is uniform in size, non-irritating, and of distinctive blue color Boilable



NO		INCHES IN TUBE	DOZEN
550	WITHOUT NEEDLE	60	\$3 00
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954	WITH 1/2-CURVED NEEDLE	20	2 40

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**F**OR GASTRO-INTESTINAL suturing and for all membranes where minimized suture trauma is desirable Integrally affixed to 20-day Kalmerid catgut Boilable

THEY DO NOT BEND HERE



ILLUSTRATIONS ARE FIVE EIGHTHS SIZE

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Less 20% discount on one gross or more

Sizes 00 0 1

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*D&G Sutures are obtainable from responsible dealers everywhere, or direct, postpaid*

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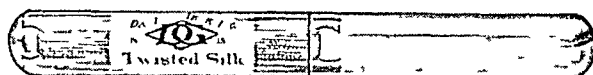


NO		INCHES IN TUBE	SIZES
350	CELLULOID-LINEN	60	000,00,0
360	HORSEHAIR	168	00
390	WHITE SILKWORM GUT	84	00,0,1
400	BLACK SILKWORM GUT	84	00,0,1
450	WHITE TWISTED SILK	60	000 TO 3
460	BLACK TWISTED SILK	60	000,0,2
480	WHITE BRAIDED SILK	60	00,0,2,4
490	BLACK BRAIDED SILK	60	00,1,4

### BOILABLE

Package of 12 tubes of a size \$3 00  
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NO		INCHES IN TUBE	SIZES
802	PLAIN KALMERID CATGUT	20	00,0,1,2,3
812	10-DAY KALMERID "	20	00,0,1,2,3
822	20-DAY KALMERID "	20	00,0,1,2,3
862	HORSEHAIR	56	00
872	WHITE SILKWORM GUT	28	0
882	WHITE TWISTED SILK	20	000,0,2
892	UMBILICAL TAPE	24	1/8-IN WIDE

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Package of 12 tubes of a size \$1 50  
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UNIVERSAL NEEDLE FOR SKIN, MUSCLE, OR TENDON

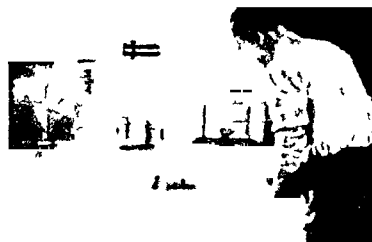


NO		INCHES IN TUBE	SIZES
904	PLAIN KALMERID CATGUT	20	00,0,1,2,3
914	10-DAY KALMERID "	20	00,0,1,2,3
924	20-DAY KALMERID "	20	00,0,1,2,3
964	HORSEHAIR	56	00
974	WHITE SILKWORM GUT	28	0
984	WHITE TWISTED SILK	20	000,0,2

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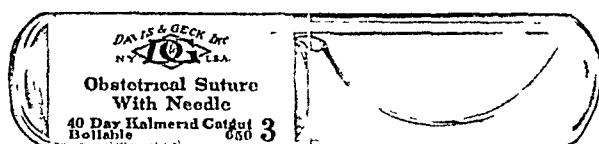
Package of 12 tubes of a size \$2 40  
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Less 20% on gross or more or \$34 56, net, a gross

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All sutures are gauged by the standard catgut sizes as here shown

000	_____	4	_____
00	_____	6	_____
0	_____	8	_____
1	_____	16	_____
2	_____	24	_____
3	_____		

\*These tubes not only may be boiled but even may be autoclaved up to 30 pounds pressure, any number of times, without impairment of the sutures

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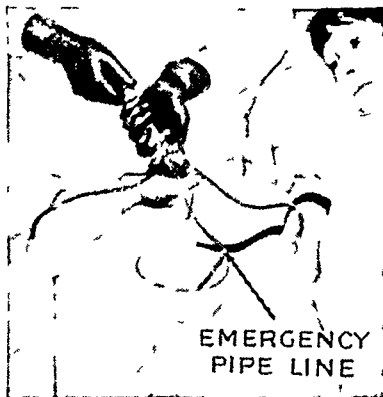
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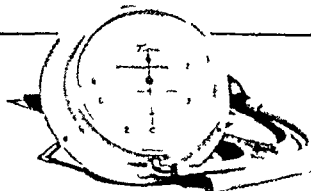
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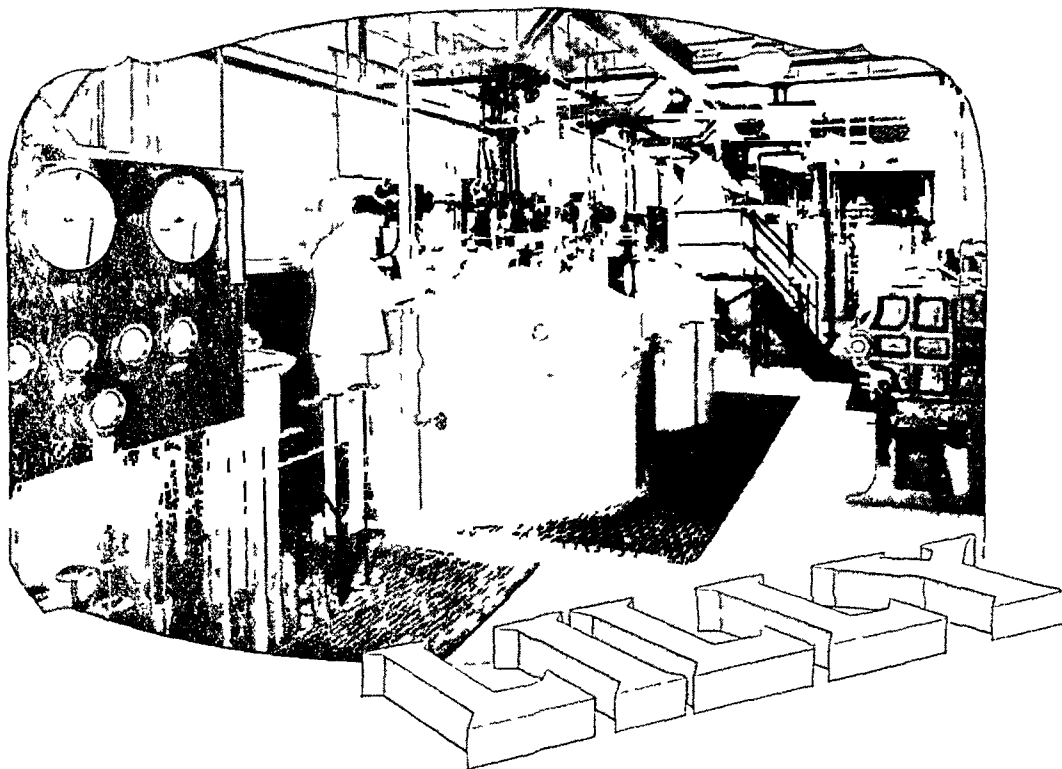
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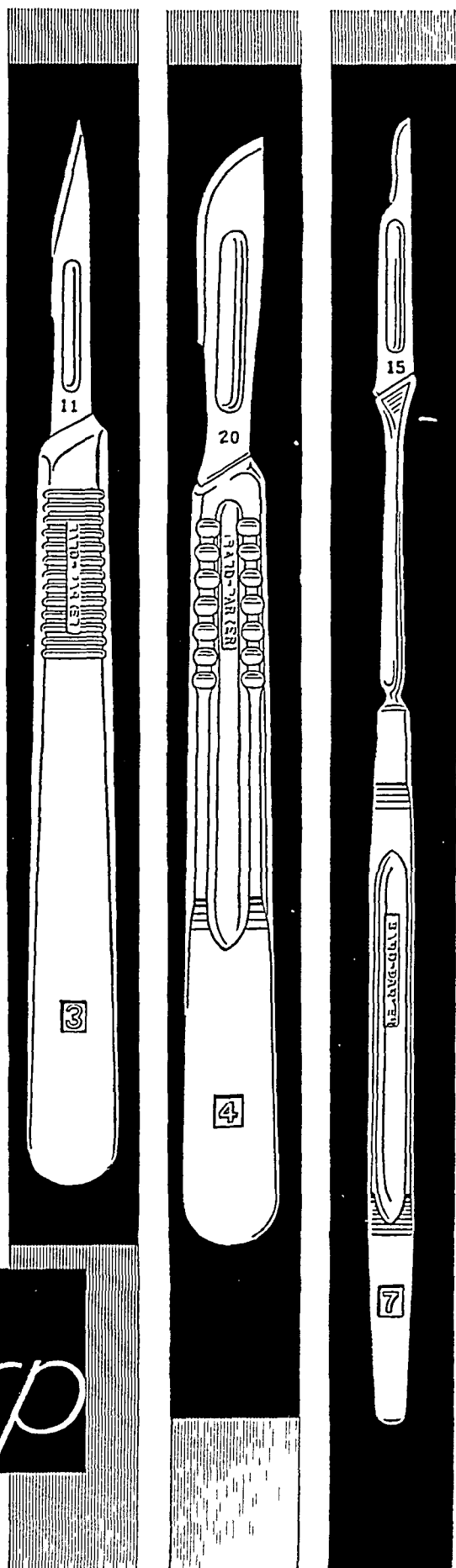
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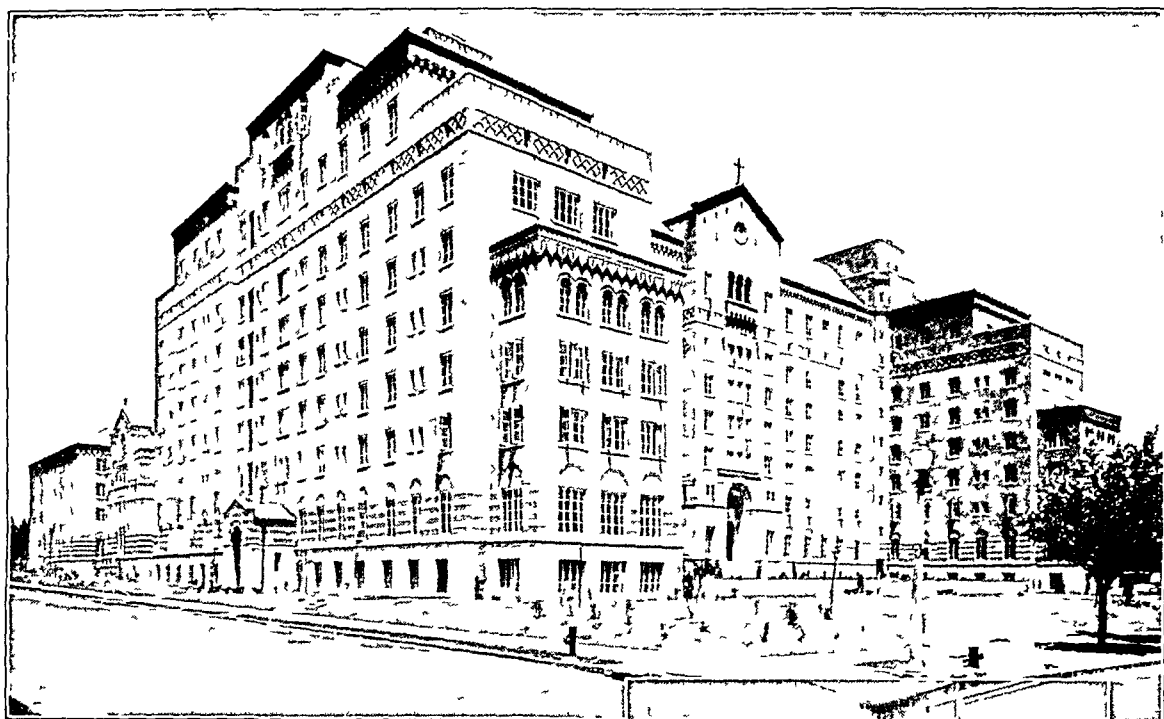
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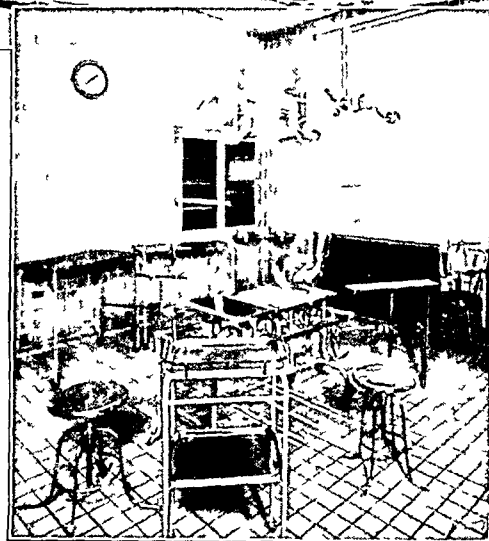
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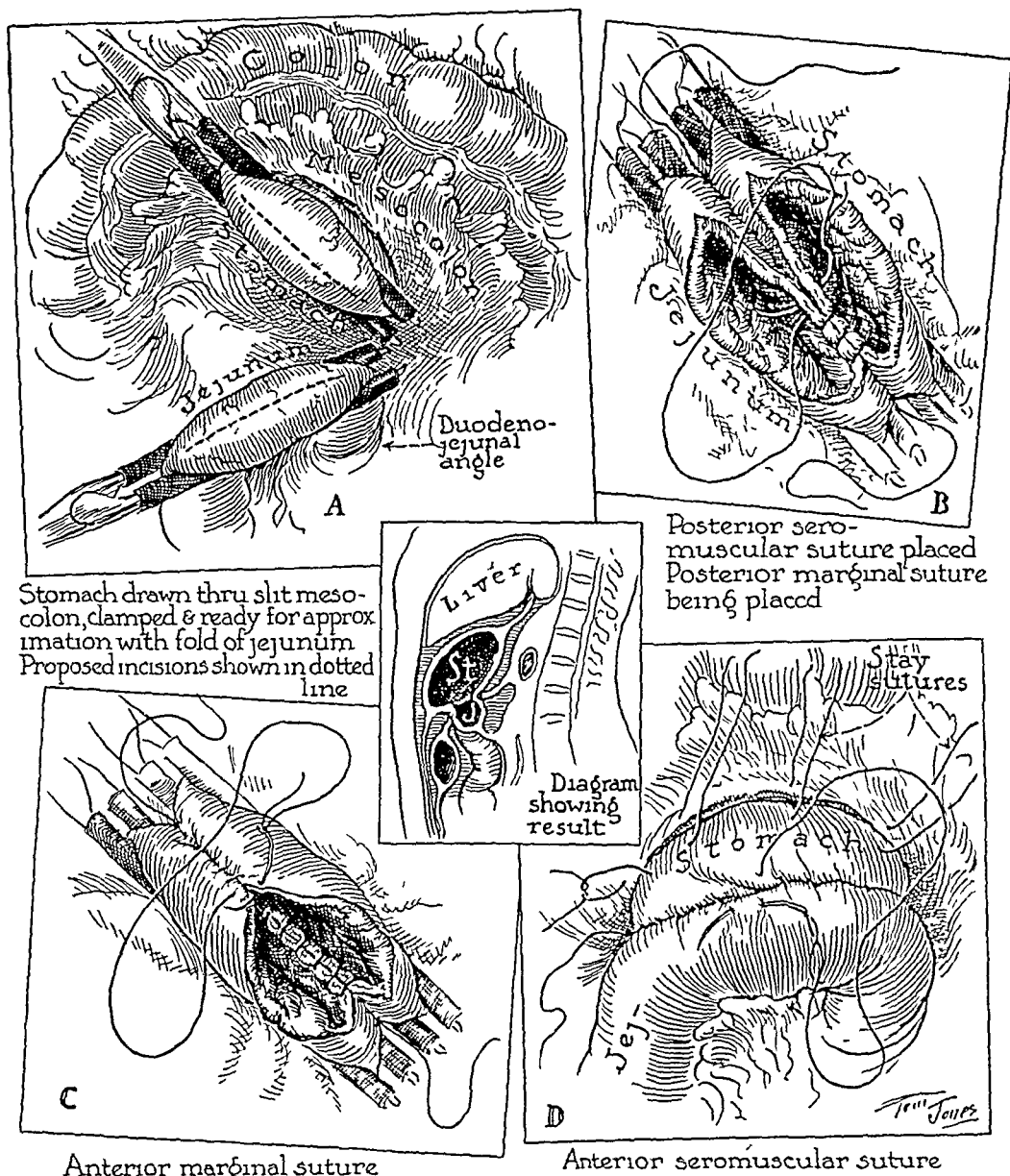
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# ANNALS *of* SURGERY

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No 6

## BACTERIAL SYNERGISM IN DISEASE PROCESSES

WITH A CONFIRMATION OF THE SYNERGISTIC BACTERIAL ETIOLOGY OF A  
CERTAIN TYPE OF PROGRESSIVE GANGRENE OF THE  
ABDOMINAL WALL<sup>†</sup>

BY FRANK LAMONT MELENEY, M D  
OF NEW YORK, N Y

FROM THE BACTERIOLOGICAL RESEARCH LABORATORY OF THE DEPARTMENT OF SURGERY, COLUMBIA UNIVERSITY, AND  
THE PRESBYTERIAN HOSPITAL OF NEW YORK CITY

SYMBIOSIS has been studied extensively by zoologists and botanists but it has not been given the attention that it should receive from the medical sciences. The term signifies the living together of two different species either of plants or of animals, or of a plant with an animal. There is fossil evidence that this is a very ancient phenomenon of nature and many believe that it is the most potent factor in the origin of species. Wallin,<sup>1</sup> in his book on symbiogenesis, uses the term proteotaxis to describe the innate tendency of one organism or cell to react in a definite manner to another organism or cell. This may be positive or negative and positive proteotaxis may result either in parasitism or symbiosis. Parasitism implies some combination in which the parasite benefits while there is either a harmful or an indifferent response on the part of the host. The term symbiosis is applied to those cases in which mutual benefit is derived by the associated organisms. Steche<sup>2</sup> considers that parasitism and symbiosis are similar relationships. In the former, one cell lives at the expense of the other and in the latter there is a balanced condition not injurious to either and usually beneficial to both. Parasitism is a battle, symbiosis an armistice or an alliance. In symbiosis each partner uses the other. It is usually a matter of trade—with each one giving something of no value to itself and receiving something of great value to itself. If at any time one of the partners cannot fulfill the necessities of the other, a parasitic battle ensues which usually results first in the death of the weaker and then in the death of the stronger. Under other conditions parasitic states may gradually change to symbiotic states. On this basis Rheims<sup>3</sup> suggests that in many cases in which individuals have recovered from symptoms of tuberculosis they are really living in symbiotic relationship with the tubercle bacillus. On the other hand, Rheinheimer,<sup>4</sup> while he holds to the importance of symbiosis in the processes of evolution, believes that parasitism and symbiosis are at opposite poles. To quote him

"The symbiotic relation is characterized by reciprocal differentiations of a progressive order, by due compensation as between the partners, by widely availing usefulness in the web of life. Parasitism, on the other hand, is the denial of such reciprocity, the undoing of its good effects. It is the antithesis of symbiosis, as the facts bear out

<sup>†</sup> Read before the New York Surgical Society, May 13, 1931

abundantly when they are stripped of misleading details. Symbiosis is a good relation, parasitism is an evil one. Good and evil, of course, are relative terms. But once we have a standard by which reliably to judge biological activities and their results, we need not shrink from the attempt to discriminate between legitimate and illegitimate developments, and thus to introduce order into biology in the place of the present chaos and indeterminateness of jargon. The claim made by some that biology is not a matter of values is preposterous. It is a species of scientific fatalism no longer warranted today. The very term 'survival of the fittest' involves a value-judgment. There is no cause for fatalism or pessimism on a due appreciation of symbiosis, no cause to falter and to think that Nature sanctions crime equally with good conduct. True, in the course of evolution, legions of species have strayed from the symbiotic path and have elected instead that of least resistance—that of predacity or of parasitism. But it can be shown that they have declined accordingly, whilst others, which have persisted in a more honest course, have meanwhile gone forward."

On this basis, Rheinheimer offers a new theory of disease concurrently with that of symbiosis. He says "Disease, degeneration and extinction originate with failure of cooperation, be it between organs or species." Wheeler<sup>5</sup> states in an article on "Social Life Among the Insects" that "Living beings not only struggle and compete with one another for food, mates and safety, but they also work together to insure to one another these same indispensable conditions for development and survival." Hastings<sup>6</sup> says that "Life is not only a struggle for existence among half-starved individuals thirsting for each other's blood but plants and animals of different kinds cooperate to a much larger extent than was formerly supposed."

One of the best examples of symbiotic existence is the lichen. A lichen is formed by the intimate association of a fungus and an alga. They perform an important function in serving as the advance guard of vegetation by reaching out over the desert and into the cold of the north and by climbing mountains to the snow line. They cover bare regions of land and are often followed by other vegetation. Fungi grow around and in the cortical layers of the roots of certain plants and trees. A still more important function is performed by nitrifying bacteria, such as *Bacillus radicicola*, which occur in the soil. They enter the root hairs of leguminous plants and grow within the roots, forming nodules. These bacteria take up nitrogen from the air and supply the roots with nitrates, accepting in return carbohydrate for their own nourishment. Bacterial mixtures play an extremely important function in the disintegration of animal bodies. Many other instances of these relationships could be cited but these will serve to indicate the importance of the general laws of symbiosis without which life as it exists on the earth would cease.

Since the early days of bacteriology it has been observed that different species of bacteria frequently exist together but very few reports have been made with regard to the effects that these organisms have on one another. Since the time of Koch<sup>7</sup> much greater importance has been placed upon obtaining organisms in pure culture. Even during the Great War, when wound infections with mixtures of organisms were commonly observed, there is very little evidence in the literature that much thought was given to the symbiosis of these organisms. In the intestine of man and of animals bacteria have

## BACTERIAL SYNERGISM IN DISEASE PROCESSES

symbiotic relationships some of which are mutually beneficial while others are antagonistic. It is still a moot question whether or not this state of affairs is beneficial to the host.

The symbiosis of bacteria has been observed in the laboratory for a long time. Certain species of bacteria completely inhibit the growth of other species. Certain species have an adjuvant action on the growth of other species. Still other species combine and perform certain functions which neither of them can perform alone. This combined activity has been called synergism.

### BACTERIAL SYNERGISM

Most of the observations that have been made with respect to bacterial synergism have been made by chance in the laboratory and have had no clinical importance. Some of these, however, are of considerable importance commercially. Pasteur<sup>8</sup> found that anaerobes could grow in the presence of free oxygen providing that aerobes were present, and he explained this phenomenon by suggesting that the aerobes used up all of the available oxygen. McLeod<sup>9</sup> has tried to explain this symbiotic relationship by demonstrating that the anaerobes are not able to produce peroxidase enough to destroy the peroxides which are formed when growth takes place in the presence of free oxygen, but if aerobes are present they furnish the peroxidase which destroys or neutralizes the peroxide which would otherwise kill the organisms. Herter<sup>10</sup> in his book on the infections of the digestive tract states that were it not for this symbiotic action of anaerobes with aerobes the former could only exist in the large intestine which is without oxygen, for oxygen is present in the small gut. Ward<sup>11</sup> noted that certain fermentations in ginger beer were due to a combination of a yeast with the bacterium. Nencki<sup>12</sup> showed that the bacillus of symptomatic anthrax and a micrococcus together produced butyl alcohol from a fermentable carbohydrate, when neither of them could do it alone. Castellani<sup>13, 14, 15</sup> has been interested in the subject of bacterial synergism for some time. His first observations were made in a study of bakers' yeast in Ceylon. When he separated the many species of organisms in the yeast he found that his pure cultures would not produce gas but when certain combinations were made, gas was formed. Castellani later carried his observations to pathogenic bacteria and found that gas was formed in media containing certain of the complex carbohydrates by the synergism of two species while the pure cultures of the individual organisms failed to produce it. Thus *Bacillus typhosus* with *Bacillus morganii* produced gas with maltose and similar effects were obtained with dysentery bacilli and certain other organisms, which were of differential importance. When these facts had been determined, it was possible by such reactions to determine the carbohydrate present if the organisms were known, or the organisms present if the carbohydrate were known. Castellani agrees with other observers in assuming that in such a symbiosis, one organism initiates the process while the other completes it. In the case of fermentation, he believes that one organism forms acid from the carbohydrate and the other produces gas from the acid. Holman and Meekison<sup>16</sup> made the same observations and came to the same conclusions. They demonstrated that in order to perform this function the two microbes must be actually growing together in intimate association, and that it was not the effect of one bacterium on the other. Sears and Putman<sup>17</sup> went into this matter of gas production a little more fully and found that bacteria could be divided into three groups: the nonfermenters, the acid formers and the gas formers. The nonfermenters never take part in this particular kind of synergism. It is always the result of a combination of an acid former with a gas former. The degradation of the sugar in question is begun by the acid former and in the course of this decomposition substances are formed which are utilizable by the gas formers and gas production results. They repeatedly failed in the attempts to produce gas by inoculating gas-forming organisms into a medium in which an acid former had been grown but which had subsequently been



sterilized either by filtration or heat, so that they believed that the second organism did not act on the end-product of the first but upon some intermediate product. Sherman and Shaw<sup>18</sup> demonstrated the synergism of two organisms in the production of propionic acid. *Bacillus acidi propionici* which is the essential organism for the production of "eyes" and the characteristic flavor of Swiss cheese, will produce a very much larger amount of propionic acid in association with several other organisms than it will alone in a medium containing lactose. The associated organisms may be either lactose fermenters or nonlactose fermenters. Ishikawa<sup>19</sup> made some very interesting observations on the synergistic action of certain bacteria. He combined not two but three different species. He confirmed the findings of others that an acid former and a gas former would together produce gas from a complex carbohydrate but if nitrogenous substances were added to the carbohydrate medium the two organisms which ordinarily, in symbiosis, would break down the carbohydrate to form gas would not do so unless there were present also a proteolytic organism to initiate the breaking down of the proteins present. The products of protein digestion favor the activity of the amylolytic enzymes. Thus, we have a synergistic action which requires the presence of three different kinds of organisms but in this instance the activity of the proteolytic organism takes place *before* and not necessarily *with* the activity of the other organisms. Theobald and Dorothea Smith<sup>20</sup> have shown that just as there is synergism with certain organisms in the production of gas there is a corresponding antagonism with other organisms. They observed that bacteria of the paratyphoid group may be divided into two classes according to the behavior of four-day cultures in lactose bouillon after a second inoculation with certain types of *Bacillus coli*. *Bacillus coli* produces gas after true hog-cholera bacilli have grown in the medium but produces no gas after other paratyphoid bacilli. Likewise Speakman and Phillips<sup>21</sup> found that characteristic production of large amounts of lactic acid by the association of *Bacillus granulobacter-pectinovorum* was prevented by some factor produced in *Bacillus volutans* cultures. *Bacillus granulobacter-pectinovorum* usually carries the fermentation down to acetone and butyl alcohol but it stops with lactic acid if *Bacillus volutans* is present. Burri and Stutzer<sup>2</sup> found that two organisms when combined would produce nitrogen gas from nitrates when neither would do it alone. They showed that one reduced the nitrate to a nitrite and the other produced free nitrogen from the nitrite.

#### BACTERIAL SYNERGISM IN PROCESSES OF DISEASE

There are very few proven instances of disease processes due to the synergism of two species of bacteria. Castellani<sup>15</sup> believes that a good many symptoms in certain diseases which are ascribed to the causative organism are really due to the association of symbiotic organisms. Among these he includes excessive tympanites with typhoid fever. He lists three definite disease entities which are due to the synergistic action of two organisms. *Trichomycosis nigra*, a disease of the hair of the axillary and pubic regions, is caused by a fungus *Nocardia tenuis* and a coccus *Micrococcus nigrescens* neither of which can alone produce the disease. *Trichomycosis rubra* is caused by the same fungus plus a different coccus. *Stomatitis cryptococcus-bacillaris* is a disease of the mouth caused by two organisms, one a fungus and the other a bacillus. Vincent's angina has been considered a disease of symbiotic organisms, a fusobacterium and a spirillum. Some authors have believed them to be morphologic variations of the same organism. Knorr<sup>23</sup> who has made some interesting laboratory studies with regard to this disease, believes them to be different organisms living in symbiosis, but he has shown that in conjunction with some of the mouth streptococci they perform certain functions which they cannot perform when separated from the streptococci. When cultures are

## BACTERIAL SYNERGISM IN DISEASE PROCESSES

made from the mouth under a seal the streptococci predominate at first, then the fusobacteria, then the spirilla and finally the spirochaetes. He believes that this shows that one prepares the ground for the growth of the others and that infection in the mouth with the fusobacterium and spirillum only occurs following a preliminary infection with streptococcus. Roux and Vaillard<sup>24</sup> noted that avirulent tetanus organisms became virulent when mixed with certain other nonpathogenic organisms such as *Bacillus proteus vulgaris*. Novy<sup>25</sup> also noted the enhancement of virulence of his bacterium of malignant oedema when it was mixed with non-pathogenic aerobes. Liermann<sup>26</sup> interested himself in the study of bacterial mixtures in certain putrefactive processes. In one such lesion he found nine different species. When he inoculated pure cultures into animals he obtained no result. Likewise, when he injected mixtures of the organisms he produced no lesion. He then inoculated media containing sterile meat with a mixture of the organisms and injected this culture

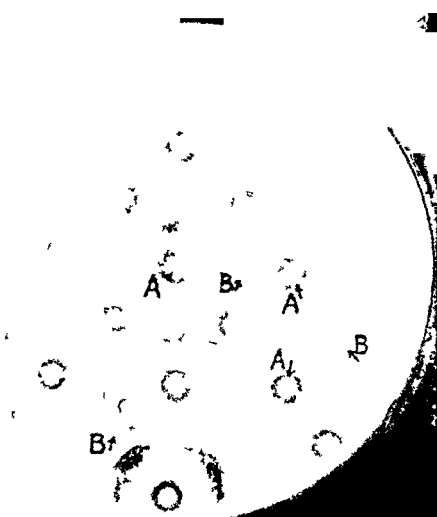


FIG 1—Hæmolytic synergism between a double zoned *Staphylococcus aureus* (A) and a diphtheroid bacillus (B) isolated from a case of chronic empyema. The diphtheroid bacillus colony (B), which is non hæmolytic, exerts an influence on the partial hæmolysis of the outer zone of the staphylococcus colony (A) which completes the hæmolysis. Print made directly from blood agar plate.

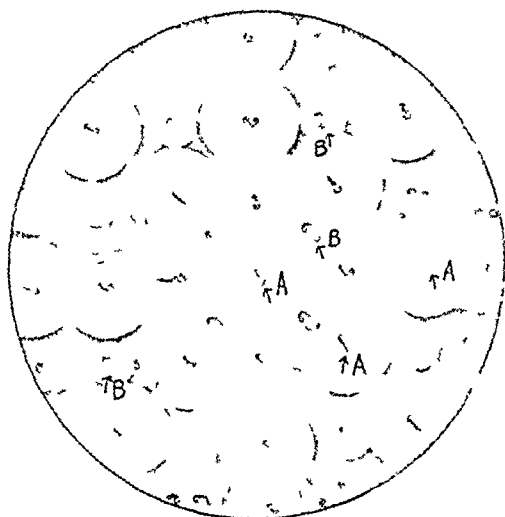


FIG 2—Hæmolytic synergism between a hæmolytic *Bacillus welchii* (double zone) and a hæmolytic *Bacillus subtilis*. The outer zone of influence of the *Bacillus subtilis* colony (B) is not visible until it comes in contact with the outer zone of the *Bacillus welchii* colony (A) where it completes the hæmolysis. Photograph of plate (therefore the reverse of Fig 1).

into animals with resulting death. Here the synergistic action was exerted upon the dead meat and toxic substances were formed which were lethal. Death was not a result of the synergistic action of the organisms on the living animal. Liermann thought that the quantitative relationship of the symbionts was important for the production of the effect but other workers have not agreed that such is the case with respect to other synergistic functions. Bienstock<sup>27</sup> observed that when protein is digested the foulest odor is given off when it reaches a homogeneous mass. This is best accomplished by the combined activity of aerobes and anaerobes. Strict anaerobes are necessary for the ultimate changes but aerobes greatly aid in the early stages of the process. Kammerer<sup>28</sup> studied intestinal organisms from the viewpoint of urobilin formation, from bilirubin. He found that pure cultures of the different strains

could not produce it alone. Certain mixtures were necessary and it was a true synergistic effect. Kammeier also studied the production of hæmatoporphyrin from hæmoglobin. He found porphyrin in the fluid from lung abscesses and when he cultured the organisms present he found that they were able to produce hæmatoporphyrin from hæmoglobin only when they were in symbiosis.

Last year I reported to the Society of Experimental Biology and Medicine some striking examples of synergistic action in the production of hæmolysis on blood-agar plates.<sup>29</sup> The phenomenon was noted with three different groups of organisms: a pair of aerobes, a pair of anaerobes and an aerobe with an anaerobe. In the exudate from a case of chronic empyema of tubercular origin, I found among other organisms present, a double-zoned *Staphylococcus aureus* and a diphtheroid bacillus. On blood-agar plates the colony of the double-zoned staphylococcus has a narrow zone of clear hæmolysis immediately around it and a wide zone of partial hæmolysis about 8 to 10 times the diameter of the colony. It so happened that when the colonies were fished from the original blood-agar culture to a fresh plate the diphtheroid bacillus and the double-zoned staphylococcus were streaked side by side. After incubation this plate showed that on the side toward the diphtheroid bacillus the outer zone of the staphylococcus colonies was completely hæmolysed over an area very evidently under the influence of some diffusible substance or physical force emanating from the colonies of the diphtheroid bacillus. Immediately around the diphtheroid colonies no change in the red cells was visible.

In order that this effect might be brought out more clearly a design was made on another plate by alternately dotting with the two cultures. Photographs of those plates show the effect produced by these two organisms when in juxtaposition. (See Fig. 1.) It was found that control nonhæmolytic colonies of several other species did not have this effect but this diphtheroid bacillus had the same effect on the outer zone of both hæmolytic and non-hæmolytic *Bacillus welchii*. If the staphylococcus was planted alone and incubated for twenty-four hours and the bacillus was subsequently planted on the same plate, the same hæmolysis of the outer zone took place. Some months later in culturing a specimen of improperly prepared surgical catgut, two anaerobic organisms were found which had exactly the same relationship to one another. They were a double-zoned hæmolytic strain of *Bacillus welchii* and a non-hæmolytic strain of *Bacillus sordellii*. The plate after anaerobic incubation gave the same appearance as the two aerobic organisms gave before.

Later, a third example of the same phenomenon was observed when, from another specimen of catgut, a hæmolytic strain of *Bacillus welchii* and a hæmolytic strain of *Bacillus subtilis* were found. The *Bacillus subtilis* colony had a narrow zone of clear hæmolysis about it and an outer zone of influence not visible until it came in contact with the outer zone of the hæmolytic *Bacillus welchii* colony which it completely hæmolysed. (See Fig. 2.)

In our recent study of the organisms in raw catgut we found two instances in which a combination of the organisms found in a single specimen of catgut produced a lethal effect when injected into an animal while the



FIG 3—A drawing of the lesion in a recent case of progressive gangrene made on the twenty seventh day after operation and two weeks after the onset of the gangrene. Note the spread in two directions.



organisms in pure culture failed to do so. In two other instances abscess and skin necrosis were similarly obtained by bacterial mixtures. In two specimens of improperly sterilized catgut we found a mixture of organisms which had a very prompt lethal effect on laboratory animals when injected together but in pure culture they were entirely nonpathogenic.<sup>30</sup> These combinations will be studied further.

Weinberg<sup>31</sup> has stressed the rôle of bacterial synergism in the etiology of acute appendicitis and has shown that certain combinations of the intestinal organisms are lethal in smaller doses than the pure cultures themselves. Our own experience in our recent studies of peritonitis tends to confirm these findings.

#### PROGRESSIVE GANGRENE OF ABDOMINAL WALL

In 1926, Dr. George E. Brewer and the writer<sup>32</sup> reported a case of progressive gangrene of the abdominal wall following the drainage of an appendiceal abscess. The gangrene developed on the tenth post-operative day in the upper half of the wound in the neighborhood of two retention sutures of silkworm gut. The lesion was characterized by an advancing zone of redness and swelling merging centrally into a purplish zone and then frank gangrene of the skin and subcutaneous tissue. The lesion was extremely painful. The gangrene progressed slowly but steadily in spite of conservative methods of treatment which included opening the wound widely, the application of various antiseptics and the local removal of the gangrenous margin. It was only controlled after a very wide excision of the whole lesion, the incision being made in normal skin 3 to 4 centimetres beyond the outer margin of the red zone. A bacteriologic study of the lesion revealed the presence of a microaerophilic nonhæmolytic streptococcus in pure culture in the periphery. This was obtained at first only by anaerobic cultures. In the gangrenous margin this organism was associated with a hæmolytic *Staphylococcus aureus* and a diphtheroid bacillus. A series of experiments in animals seemed to indicate that the association of the microaerophilic streptococcus and the *Staphylococcus aureus* was responsible for the lesion and that it was an example of bacterial symbiosis or synergism.

When Doctor Brewer reported this case at a meeting of the American Surgical Association in Detroit in 1926,<sup>33</sup> he described a previous similar case of his own and referred to similar cases reported by Cullen<sup>34</sup> and by Christopher.<sup>35</sup> In the discussion of the case, Porter, Moschowitz, and also Clinton described cases from their own experience which had not been reported. Since that time Alexander,<sup>36</sup> Shipley,<sup>37</sup> Freeman,<sup>38</sup> Mayeda,<sup>39</sup> and Probst and Seelig<sup>40</sup> have described it. In the discussion of Freeman's report, Horsley, Alexander and Ballin referred to cases which they had seen. It may be that the cases reported by Brunsting et al.<sup>41</sup> belong in this group. Altogether, eighteen or more cases of this disease have been reported. In none of the other cases were anaerobic cultures made from the margin of the lesion and the organisms which were reported to have been found in the slough were heterogeneous.

When reference has been made to our report by later authors with the exception of Brunsting<sup>49</sup> some doubt has been expressed with regard to the synergistic bacterial etiology of the disease suggested by our bacteriologic study. Clinically, however, the distinctive cases all behaved in the same way and were characterized by extreme pain and tenderness and a slowly spreading gangrene not yielding to repeated conservative operations but finally yielding to radical and extensive removal of the lesion [except two of the cases, which went on to a fatal termination]. The disease may be said, therefore, to be a definite clinical entity.

#### RECENT CASE

In January of this year a man of thirty-five came to the Presbyterian Hospital complaining of a diffuse abdominal pain of two weeks' duration. On examination his abdomen showed slight tenderness over both lower quadrants with a mass that could be felt low down close to the mid-line slightly more on the right than on the left. This was more readily felt by rectal examination. Dr. Richmond Moore, who was on call for emergencies, saw the patient and advised immediate surgical intervention. At operation an abscess was found in the pelvis containing 30 to 40 milliliters of thick, green pus. The coils of the intestines were so matted together that it did not seem wise to explore extensively. The appendix region could not be found and the origin of the abscess could not be determined. The abscess was drained by means of two cigarette drains and a large rubber tube. The peritoneum and the posterior sheath were closed with continuous sutures of chromic catgut. The anterior sheath was sutured with chromic mattress sutures and two silk-worm-gut retention sutures were placed in the upper part of the wound. On the day after operation the drains were soaked with exudate from the abscess. Cultures from the exudate yielded *Bacillus coli*, *Bacillus welchii* and a non-hemolytic microaerophilic streptococcus. On the third day post-operative a note was made on the chart to the effect that the wound was infected. The cigarette drains and the tube were gradually shortened and removed. On the eleventh day post-operative, it was observed that there was infection around the retention sutures and on the thirteenth day it was noted that "the wound had a carbuncular appearance" in the upper half. The retention sutures were removed but the swelling and necrosis continued to spread both right and left from the upper half of the wound. Up to that time the patient had been a jovial, uncomplaining individual, but he then began to complain of intense pain which increased in severity and remained constantly present, aggravated by any movement or any manipulation. His temperature did not rise. His blood count was low but the local gangrenous process continued to spread in both directions in spite of what was thought to be adequate drainage of the margins by the removal of large pieces of necrotic tissue. From day to day pieces of slough were cut away but it continued to spread. On the twenty-seventh day, upon my return from a vacation, I was asked to see the patient. The appearance of the lesion at that time is well shown in Mr. Fernberg's drawing (See Fig. 3). The lesion showed such a striking resemblance to the previous case of Doctor Brewer's that the treatment which was successful in that instance was advised, namely, wide excision of the lesion and prompt application of antiseptic fluids (See Fig. 4). This resulted in a prompt disappearance of the infection, the denuded area granulated over rapidly and on the eleventh day following this operation, the wound was covered with Thiersch grafts, which took nicely (See Fig. 5). Epithelization was complete on the twelfth day, which was twenty-four days after the excision of the lesion and fifty-one days after the original operation.

#### BACTERIOLOGICAL STUDY

Needless to say, I was delighted to have the opportunity of studying this interesting lesion again bacteriologically. Inasmuch as the disease had spread

Fig 4—The appearance of the wound on the day after excision



Fig 5—The appearance of the wound one week after Thiersch skin grafting





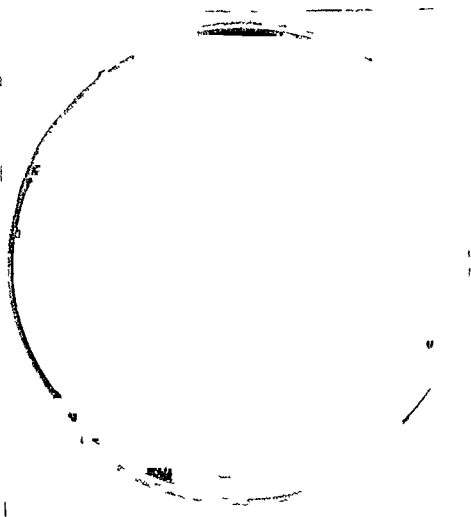


FIG 6—Pure culture of the microaerophilic nonhemolytic streptococcus from the periphery of the lesion, cultured anaerobically on a blood agar plate



FIG 7—Mixed culture of the streptococcus and *Staphylococcus aureus* from the gangrenous margin. The plate was incubated for twenty-four hours anaerobically to permit the growth of the streptococcus (pin point colonies) and then for twenty-four hours aerobically to permit further growth of the staphylococcus (large colonies)



FIG 8—Lesion in a dog forty-eight hours after injection. Marked swelling and redness with early gangrene in the centre at the site of injection of 2.5 cubic centimetres of the culture of streptococcus mixed with 2.5 cubic centimetres of the culture of staphylococcus. No swelling on either side at the site of injection of 5 cubic centimetres of pure cultures of the streptococcus (X) and the staphylococcus (O)



FIG 9—The same as FIG 8 on the fifth day. The gangrenous skin has separated. Underrunning and swelling of the surrounding skin persists

## BACTERIAL SYNERGISM IN DISEASE PROCESSES

in two directions, it was possible to study each of these lesions separately. Doctor Moore made an extensive excision of each lesion going approximately 3 to 4 centimetres outside of the zone of redness. Cultures were taken at the incision lines and the excised plaques of skin and subcutaneous tissue were transferred to the laboratory for examination. The deep surfaces were seared as before and bits of tissue taken for culture. In each case the periphery of the lesion yielded the same microaerophilic nonhæmolytic streptococcus in pure culture while the gangrenous portion yielded this organism in conjunction with

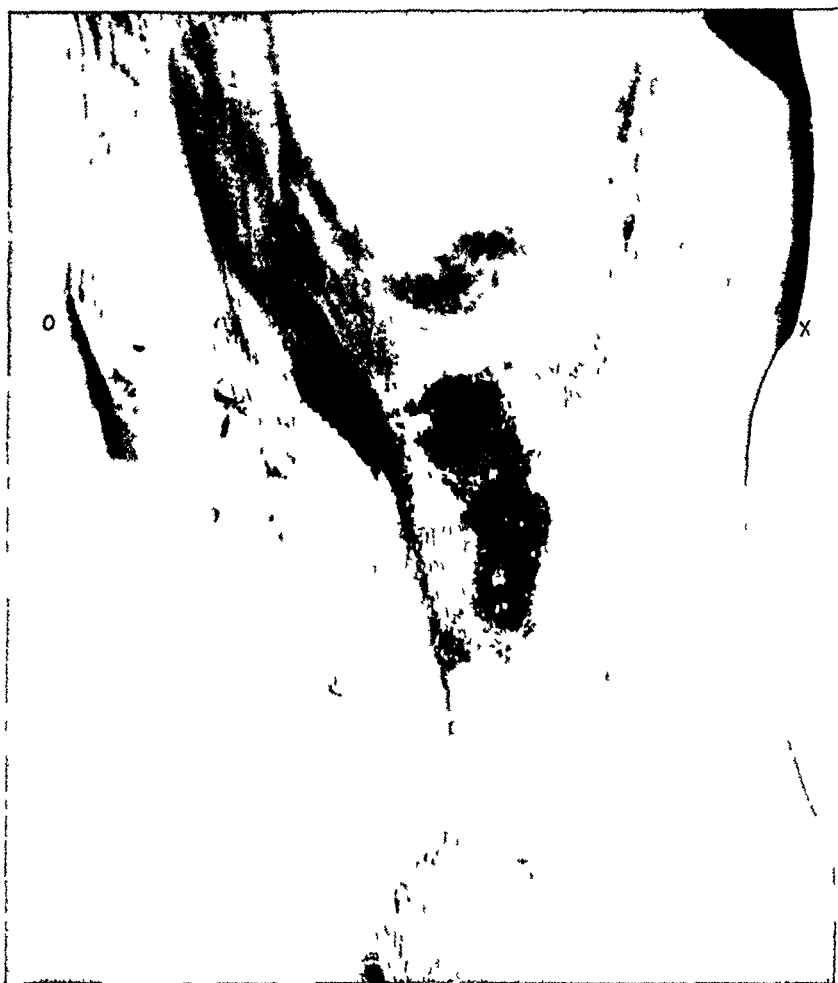


FIG. 10.—Another dog on the fourth day after injection in which the mixture (centre) caused an extensive gangrene and the staphylococcus alone produced an abscess (O). The streptococcus alone (X) was without effect.

a faintly hæmolytic *Staphylococcus aureus* (See Figs 6 and 7). *Bacillus welchii* and *Bacillus coli*, which had been present with the streptococcus in the first cultures of the peritoneal fluid, were no longer present in a viable or cultivable state. When the streptococcus and staphylococcus organisms were injected into animals as in the previous experiments, both in pure culture and in symbiosis, it was again found that the gangrenous lesion could be produced only when the two organisms were injected together, for twice the amount of each organism in pure culture failed to call forth the lesion. As with the organisms from Doctor Brewer's case, the streptococcus alone produced prac-

tically no reaction while the staphylococcus caused only a moderate swelling. The lesion in dogs and guinea pigs is shown in Figs 8, 9, 10, 11 and 12.

Having confirmed to the letter the findings in our previous case, it seemed to be worth while to go farther and try to find out something of the mechanism of the reaction. A microscopic study of the lesion revealed the fact that there was an extensive fragmentation of the dense subcuticular connective tissue and a heavy cellular infiltration of the subcutaneous fat. There was no evidence of a thrombosis of blood-vessels. The vessels were universally dilated and filled with blood with a large number of polymorphonuclear cells clinging to the walls. From a morphologic viewpoint it seemed evident that the gangrene was due to a direct action of some lytic substance on the tissue rather than to a cutting off of the blood supply. Gram stains of the tissue revealed masses of Gram-positive cocci toward the centre of the lesion and scattered organisms in diplo form or in short chains out toward the periphery. No amœbæ were seen such as have been reported in certain somewhat similar ulcerative lesions.<sup>41</sup> These cases were not studied for the presence of anaerobic organisms. It may be that they were of synergistic bacterial etiology and were secondarily contaminated or infected with amœbæ. Dr F W O'Connor of our department of tropical diseases has confirmed the absence of amœbæ in our two cases.

In our study we have attempted to answer the following questions. What was the source of these organisms? Have they any cultural peculiarities or biologic properties which will serve to demonstrate their synergism *in vitro*? Does one organism prepare the ground for the other, or must they work together? Is the gangrene a phenomenon of sensitization? Can the lesion be produced by bacterial filtrates or by the filtrate of one organism acting as an adjuvant to the other organism? Is the combination a specific one or will other combinations produce the same effect? Can a similar effect be produced in certain organs or in the peritoneum as well as in the skin? We have not answered all of these questions but present the results of our study as far as it has gone.

Inasmuch as the streptococcus was found in pure culture in the advancing zone of the lesion in both cases, it seems reasonable to suppose that it is of fundamental importance in the production of this particular lesion, or I might say these particular cases.

The microaerophilic streptococcus is one of a group which occurs frequently in the human intestine and in peritoneal exudates. It is usually missed unless careful anaerobic cultures are made. In a recent bacteriologic study of a series of cases of peritonitis following perforation of the appendix or gut, we found that intestinal streptococci form a large percentage of the bacterial flora of the peritoneal exudates.<sup>42</sup> There are many species and varieties of streptococci in the intestine including the heat-resistant enterococci, the green and also the nonpigment-producing streptococci, true anaerobic streptococci, and a group of microaerophilic streptococci which prefer an anaerobic environment and for the first cultivation must be obtained by anaerobic methods but after several transplantations on artificial media they will grow on the aerobic plates as well. From our peritoneal exudates we cultivated these organisms many times and Wernberg

and his co-workers<sup>21</sup> found them in the contents of acutely inflamed appendices. Several classifications of intestinal streptococci have been made recently for example, those by Alston<sup>22</sup>, and by Welch<sup>23</sup>, and also by Dible<sup>24</sup>, which have not taken into account either these organisms or the strictly anaerobic streptococci. Tissier<sup>25</sup> isolated an anaerobic streptococcus from a stool of a man with a putrid enteritis. The anaerobic streptococci of gunshot wounds so frequently reported during the War were presumably of intestinal origin. Prevot<sup>26</sup> has given one of the best summaries of the anaerobic streptococci analyzing the reports of previous workers and adding his own experiences. He studied twenty-seven strains which he obtained from patients. There were twelve cases of lung abscess, five of bronchiectasis, eight puerperal infections and two cases of appendicitis. He divided them into three groups. The first formed gas and produced a putrid odor. Of these he had seven strains. The second group were non-gas-forming and nonfetid, of which he had six strains. The third group he called "anaerobies de predilection" of which he had fourteen strains. The first two groups are strict anaerobes and the last are anaerobic on initial cultivation but after a number of artificial transplantations acquire the ability to grow aerobically. Because of this adaptability this group has been given the name of *Streptococcus evolutus*. It occurred in all of the above-mentioned pathologic conditions. The organisms which we have found in both of these cases evidently fall into this group. They correspond to Prevot's description. This organism was observed by Graf and Wittneben in 1907<sup>28</sup>. Prevot described its cultural characteristics. He also stated that "most of the strains show no pathogenicity but a few will produce slight swelling when injected under the skin of guinea pigs and rabbits and occasionally produce pus so that we must consider it as a pyogenic organism. Agglutinating antiserum may be produced and such a serum will agglutinate other strains of this group but not strictly anaerobic streptococci." Prevot did not mention the possible significance of this organism in symbiosis.

In Doctor Moore's case and in Doctor Brewer's case the streptococcus probably came from the intestine, entered the peritoneum with a perforation of the appendix and contaminated the wound of the abdominal wall at the time of operation. In neither case was the *Staphylococcus aureus* there in the first cultures. It is seldom found in peritoneal exudates. It was probably introduced either at the time of operation or afterward, possibly dropping from the air onto the sterile field in the operating room. It is frequently found in wound infections following clean operations. The rarity of the gangrenous lesion among so many drained cases of peritonitis is probably due to the necessity for the coincidence of these two organisms. The tension of the silkworm-gut retention sutures may have played a part in the establishment of the infection.

We tested the fermentation reactions of these organisms in pure culture and in symbiosis but were not able to determine any function of the pair not performed by one of them. The streptococcus fermented dextrose, lactose, saccharose and salicin but not mannite. The staphylococcus fermented the first three and mannite but not salicin. Both are acid formers and neither is a gas former. The effect on gelatin, milk and Loeffler's coagulated blood serum likewise showed no synergistic action. Both liquefied gelatin and coagulated milk with a retraction of the clot. Loeffler's serum was not liquefied. Digestion of protein, fat and carbohydrate similarly failed to point the way to any synergistic enzyme action as far as our limited tests were concerned. We found that the lesion could be produced only when the organisms were injected together—either having grown together overnight or having



FIG 11.—The lesion in a guinea pig. Anteriorly (at X) 2 cubic centimetres of streptococcus culture were injected. Posteriorly (at O) 2 cubic centimetres of streptococcus were injected without effect. In the centre 1 cubic centimetre of each was injected with extensive gangrene. The slough has separated—sixth day.



FIG 12.—The lesion in a guinea pig with the streptococcus and a control staphylococcus—the same amounts of culture as indicated in FIG 11.

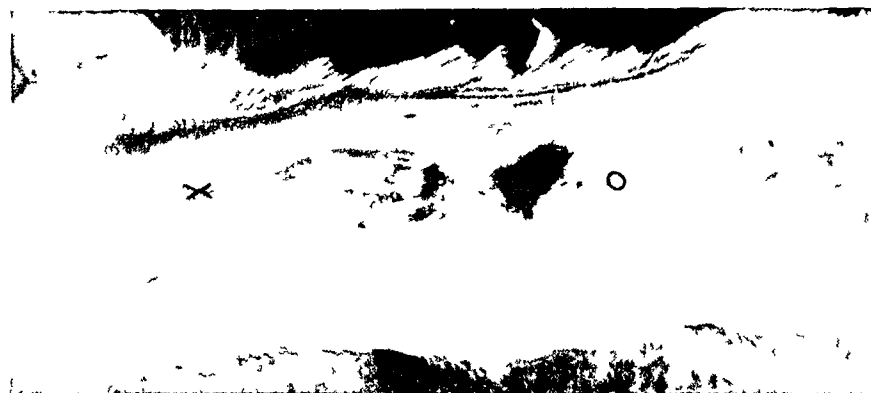


FIG 13.—The lesion in a guinea pig with the area of the staphylococcus injection (X) approximating the area of the mixed culture injection. In this region there is a semilunar area of necrosis. The area of streptococcus injection (O) is unaffected.

been mixed together just before injection. If they were injected separately even in close juxtaposition the association was not close enough and sufficient mingling did not take place to produce the lesion. If one organism was injected alone and the other organism was injected at the same site on the next day we could never produce the lesion. Whether this was due to the fact that a large proportion of the original injection had been removed or a protective mechanism had been called forth by the first injection to withstand the onslaught of the combination we have not yet determined. It cannot be said, therefore, that one organism prepares the ground for the other to produce the gangrenous effect.

Filtrates from these organisms did not produce this lesion even when a few organisms are present, as in the centrifuged supernatant fluids of cultures



FIG 14—X-ray pictures of the lungs of the rabbits (after removal) into which the infected barium and agar emboli were injected twenty five days previously. P—*Streptococcus* alone—very small lesion in one lung. F—*Staphylococcus* alone—moderate lesions in both lungs. PF—Symbiosis with half the dose of each organism—extensive lesions in both lungs.

and the filtrate of one with the whole culture of the other did not produce gangrene although the swelling was somewhat more pronounced than with the pure culture alone.

Certain other staphylococci with the streptococcus will sometimes produce the lesion so that the staphylococcus is not specific. (See Fig 12.) None of the control staphylococci, however, produced as extensive a lesion as the organism cultured from the patient in question. When the lesion is produced by injecting a combination of the two organisms and the control injections of the pure cultures are in close proximity, the margin of the area receiving the staphylococcus injection toward the central lesion will take on the gangrenous appearance but the corresponding margin of the area receiving the streptococcus will not be affected. It may be that in the combined lesion the strepto-

cocci spread more widely than the staphylococci and reach the site of the staphylococcus injection in sufficient concentration to produce the lesion. Or it may be that it takes a smaller dose of the streptococcus to activate the staphylococcus than *vice versa*. This effect is shown in Fig. 13.

When doses which are adequate to produce the lesion in the skin were injected into the peritoneum of guinea pigs, there was no evidence of disease. The peritoneum was able to take care of large numbers of bacteria in a free broth culture but when the culture was incorporated with barium in a cylinder of agar, the combination of the streptococcus and staphylococcus caused a progressive loss of weight, resulting in death in four days. The staphylococcus alone with a double dose resulted in death two days after the combination but without showing any illness the day before death. The streptococcus alone produced no ill effects whatsoever.

The fact that this type of streptococcus is so frequently found in lung abscesses led us to attempt to produce this lesion in animals. A suspension of equal parts of barium sulphate and 2 per cent melted agar was sterilized by boiling and then cooled to 40° C. This suspension was poured into three small bottles and the cultures of streptococcus and staphylococcus were then added separately and together. The mixture of staphylococcus and streptococcus contained half of the number of each organism which was used in the pure cultures. After thoroughly mixing the cultures with the barium and agar it was allowed to solidify. With a large syringe needle a cylinder was then cut about 25 millimetres in length and 1.5 millimetres in diameter. To ascertain its presence in the needle, it was first expelled into a sterile dish and then sucked up into the needle again. With a small amount of saline in the syringe these plugs were then injected into the jugular veins of three rabbits. X-rays showed that although they broke up to some extent in passing through the heart they generally were caught in one or both lower lobes. X-rays of the lungs were then taken at intervals of two to three days. Five days after injection, the rabbit which received the mixture of organisms began to lose weight and the X-ray film showed an infiltration of the lungs around the infected emboli. This rabbit continued to lose weight while the others appeared normal. Later X-rays showed progression of the lesion in both lungs. After fifteen days, however, the X-ray of the rabbit receiving staphylococcus alone showed infiltration around the emboli. The animals were then sacrificed and the lungs were removed. All three showed adhesions of the lung to the diaphragm in the region of the emboli. The streptococcus embolus produced only an infarct. The staphylococcus alone produced a pneumonitis involving the lower third of both lungs. The combination of organisms resulted in a much more extensive involvement—at least three-quarters of both lungs being consolidated. This study will be carried further but these experiments suggest that in the lungs also these organisms have some adjuvant action upon one another.

#### DISCUSSION

In connection with the two cases of progressive gangrene of the abdominal wall, these points should be emphasized. Both occurred following

the drainage of a peritoneal abscess, presumably of appendiceal origin. In both, the streptococcus was present in the first cultures. In both cases the peritoneal infection took care of itself. In both the gangrene developed in the region of silkworm-gut retention sutures. Both complained bitterly of the pain associated with the lesion. In both, conservative treatment failed to check the progress of the disease. Both recovered promptly after the wide excision of the lesion. In both instances the microaerophilic streptococcus (anaerobic by preference) was found in pure culture far out in relatively normal tissues and in the red zone beyond the gangrene. In both cases the gangrenous tissue contained both the streptococcus and the staphylococcus. Practically identical results were obtained when the organisms from these two cases were injected into experimental animals. These facts would seem to indicate that these organisms were responsible for the lesion and suggest that in similar cases they may be found again. It is hoped that attempts will be made to confirm these findings in other cases.

These facts also indicate the importance of making anaerobic cultures in all cases with peritoneal exudate. If seemingly anaerobic streptococci are found, this lesion should be watched for. It is possible that the organisms would not have gained a foothold in the wound, if it had not been partially closed with retention sutures at the original operation. The possibility of the development of this type of infection must be considered another reason why the skin and subcutaneous tissues should be left widely open after drainage of an intraperitoneal abscess. If such a lesion develops, wide excision is indicated to bring about prompt relief and to prevent further destruction of the abdominal wall.

The fact that these organisms have an adjuvant action upon one another seems to be confirmed by the animal experiments. The nature of this phenomenon has not been clearly shown and will have to await further experimentation. The results of our study so far seem to indicate that one organism does not initiate a process which the other completes at a later time as is the case with a combination of proteolytic and saccharolytic organisms. Our study indicates rather that it is necessary for them to be growing together intimately and that the product which is the cause of the gangrene is made by the action of one organism on some intermediate product of metabolism produced by the other, as is the case with certain combinations of fermentative bacteria.

Hæmolytic synergism as illustrated by the two organisms isolated from the case of chronic empyema may have been of minor significance in the illness from which the patient suffered but its occurrence is suggestive of the possibility of the synergistic effects of mixed infections which are not so obviously demonstrated.

The lethal action in laboratory animals of mixed cultures found in raw and insufficiently sterilized catgut, which could not be duplicated by pure cultures of those organisms, indicates clearly that we must not be content merely with the destruction of the so-called pathogenic bacteria in catgut, but all species without regard to their intrinsic pathogenicity. In such toxins we may find the



explanation of the profound toxæmia of some cases of intestinal obstruction and certain cases of peritonitis which toxæmia may be absent in other cases, apparently similarly obstructed or with an equally extensive peritonitis

The production of a skin lesion with doses which are well tolerated by the peritoneum may be explained by the relative speed of absorption from those two tissues or a special predilection of the staphylococcus and streptococcus for the skin and subcutaneous tissues. The production of disease within the peritoneum with much smaller doses when contained in an agar plug is consistent with the former hypothesis

The production of hæmatoporphyrin in lung abscesses and urobilin in the intestine by the combined action of bacteria are again indices of other possible reactions which cannot be so easily demonstrated but which may be much more significant as factors in disease

When two or more organisms are associated in the production of a disease process in man, they are in symbiosis with one another but are parasitic with respect to the man. The fact that they produce the disease in combination when they cannot do it alone suggests that their association is of mutual benefit to them while it is harmful to the common host

Clinically it has been observed repeatedly that mixed infections are usually worse than infections with a single species, for example—tendon-sheath infections with streptococcus and staphylococcus and tuberculosis with pyogenic empyema, arthritis or lymphadenitis. We recently observed in our post-operative wound infections following clean operations that the majority of serious infections yielded more than one species of organism while the majority of trivial cases yielded a single organism. Human bites frequently produce alarming and serious infections when the only organisms which can be obtained on culture are nonpathogenic in pure culture. The complications of measles and whooping cough with their "secondary invasion" of other organisms (particularly streptococci) might well be studied from a symbiotic viewpoint. These clinical observations have been common but very little study has been made to determine whether they represent a summation of effects or synergistic phenomena

#### SUMMARY

We have tried to emphasize the importance of symbiosis in various processes of life

We have given some illustrations of the synergistic action of bacteria in certain *in vitro* experiments in the laboratory which may have no clinical significance but which indicate the possibility of other synergistic effects which may not be so easily demonstrated but which are significant in disease processes

We have reviewed the synergistic diseases and the disease processes which have been observed by other authors and have added certain observations of our own, namely

(1) The hæmolytic synergism of two organisms found in the exudate in a case of chronic empyema

## BACTERIAL SYNERGISM IN DISEASE PROCESSES

(2) The lethal effect in experimental animals of a mixed culture of organisms found in unsterile catgut which could not be produced by the same organisms in pure culture

(3) The adjuvant action of organisms found in cases of peritonitis demonstrated by the production of death with small fractions of minimal lethal doses of these organisms when injected together

(4) The almost exact duplication of bacteriologic findings in two cases of progressive gangrene of the abdominal wall following the drainage of a peritoneal abscess. These cases both yielded a microaerophilic streptococcus and a *Staphylococcus aureus* capable of producing a gangrene of the skin and subcutaneous tissues, when injected together into experimental animals, while the pure cultures failed to produce the lesion

(5) The adjuvant action of these same organisms when injected into the peritoneum and lung under certain conditions

### CONCLUSIONS

Certain bacteria have a synergistic function in the production of certain types of disease or symptoms of disease

This synergistic action should always be kept in mind in studying disease processes involving tissues, organs, or systems in which mixtures of organisms are frequently or occasionally found

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# SPINA BIFIDA

A CLINICAL STUDY WITH A REPORT OF TWELVE PERSONAL CASES

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THE successful repair of any serious congenital defect in the new-born ordinarily carries with it its own reward To feel that one has overcome a defect of nature on behalf of an unfortunate infant should beget a gratifying self-satisfaction With regard to most of the operable congenital defects this is true, but in the case of spina bifida, my personal experience has not always been entirely satisfactory Although the operations have all been technically successful, there are some among those patients who, it seems to me now, would have been better left unoperated upon That a single case of paralysis of bladder and rectum in the new-born, associated with myelocoele of any variety, has ever been cured by operation is not likely A somewhat extensive reading of the literature has only strengthened this opinion And since it is highly probable that all such paralyses are due to defective cord development, any cure by operation is not likely in future Therefore, the author, with regard to these babies, like the first surgeon pioneers in this field, von Recklinghausen and Hildebrand, feels that it is better to leave them unoperated upon

The incidence of spina bifida is usually placed at about one in each thousand births Harrar, in 1916, found fifty-nine cases in 91,600 at the New York Lying-in Hospital The report of the London Clinical Society's Committee for the study of spina bifida in 1885 gives twenty-two in 22,293 births at the Paris Maternite In an examination of pathologic embryos, Mall found it twelve times in 163 and Panum thirty-eight in 404 From this Mall deduces that for each case which goes to term at least five are aborted

The condition is said to have been named by Tulpus (Ranke) in 1641, but it was not until the early years of last century that it became of much scientific interest The younger Saint-Hilaire, in 1832, described it and refers to the various types, even the rare anterior variety and the syringo-myelocoele In fact, he insists that the name spina bifida can be *correctly* applied only to those of the anterior variety The name "fissure spinale" he gave to the usual varieties He refers to it as an arrest of development similar to anencephalus, describes the usual accompanying deformities and discusses the different varieties and their most common sites Cruveilhier (1849) refers to it as "une hernie aqueuse" sometimes containing the cord in the sac He asserted it was *not* due to hydrocephalus, which it often accompanied, they were both due to a common cause—"hydropsie" Forster (1861) made certain observations, and Rindfleisch (1863) discusses the condition, especially the anterior variety He argued that this was a consequence of the failure of

the arches to unite and due to muscle pull Ranke (1878) treated the subject at length. He deplored the fact that his colleagues had failed to give proper credit to the French and especially to Cruveilhier. Ecker, in 1880, studied a four-millimetre embryo with a wide-open sulcus. Tourneux and Martin (1881) published a microscopic study of ten cases (one an embryo of eight millimetres). They described sub-arachnoid pockets and the relations of the spinal ganglia, and traced the cord to the roof of the sac. They credit Bevalet (1857) with the observation of the transverse arrangement of the nerves of the cauda when this region is affected. Cleland (1883) gives a quite detailed study of nine specimens. The interest in the subject in England led to the appointment of a commission for its study by the London Clinical Society in 1882. This commission made its report in 1885, and that year also there appeared a lecture by Humphrey—illustrated with specimens from the Hunterian Museum. On reading this one feels that with regard to its pathology, all that has been added since is the nomenclature, and this was given us by von Recklinghausen (1886).

As to the particular cause of the condition, we are still ignorant. Panum (1878), Dareste and Fere (1893), and Morgan (1909), by variations of temperature, trauma, chemicals or position, produced certain deformities in chicks, among others, spina bifida. Mall was of the opinion some malformations were hereditary and others produced in a mechanical way, and Baldwin (1915) claimed to be able to produce spina bifida at will by the use of the violet ray. On reading the article, I think it is a bifurcation of the spine rather than the surgical condition known as spina bifida he has so produced.

Ranson makes the statement that the neural groove is the most conspicuous part of a 2.4-millimetre embryo, and the following facts seem to have been agreed upon by embryologists for so long they are no longer questioned. The neural groove closes by the approximation of its walls—all but its very bottom is thus obliterated. This part becomes an epithelium-lined tube and from it is developed the central nervous system. The closure of the tube begins in the cervico-dorsal region and progresses caudad and cephalad. By the end of the third week the groove has disappeared, but two openings—the neuropore towards the cephalic end, and the caudopore towards the caudal end—remain open for some time longer. The vertebral arches should unite and form a canal for the cord by the end of the eleventh week. Until the end of the third month, cord and spinal column are equal in length and rate of growth. From this time on the column lengthens faster than the cord. The anterior ends of the cord and spine being fixed at the head level, the lower end of the spine grows away from the cord, so that at birth the end of the cord comes to about the level of the third lumbar.

But just why union of the edges of the neural groove should fail in part or entirely as so happens in spina bifida is no better known now than it was in the time of Saint-Hilaire. Cases are recorded wherein the vertebral bodies are cleft, half-developed, and absent entirely and these deformities have not always been accompanied by a defect dorsal to the central canal of the cord. To a dorsal cleft the name spina bifida will refer in this article, although the French name, spinal fissure, might perhaps be more appropriate.

The defect, as one would suppose, is more common in the regions where normally union of the neural groove is latest, namely, toward the ends of the spine. Moore studied all those in the Surgeon General's index up to 1905 and found 86 per cent lumbar or lower, 9½ per cent cervical and the remainder (4½ per cent) dorsal.

When the cleft reaches from the skin to the central canal of the cord, the more or less "opened-out" cord usually appears as a reddish strip from

one to two centimetres wide and of variable length lying in the centre of the back. This strip is not covered by the normal surface epithelium. It has a moist granular appearance and flakes of fibrin or inspissated mucoid, or even crust-like plaques may be seen on it. Microscopic examination reveals columnar or cylindric epithelium, unless this has been rubbed off or ulcerated. Clear fluid wells slowly up from its centre only if the cord is cleft to the canal. Around the margin of this red strip, the surface is covered usually by a thin, pearl-gray, scar-like pellicle. This usually thickens as it passes outward—may become quite hard and scar-like—and joins the normal skin abruptly. There may be no tumor at all, the surface may even be depressed, groove-like, but most often this whole abnormally covered area, with the adjacent healthy skin, protrudes more or less, depending on the tension of the subjacent cerebrospinal fluid in the arachnoid space. When a tumor exists in such a case, it is never pedunculated but always has a wide base.

The above type of spina bifida without tumor has been called myelocele, and with tumor, myelocystocele. It would simplify matters to refer to them as plane and cystic myelocele. In all these cases it is highly probable there will be accompanying paralyses. Such paralyses are due to lack of development of the cord centres and not to the cord's position, and they are therefore, not likely to be benefited by operation. Or the failure of union of the sulcus may reach from the surface of the body to the cord only, involving the arachnoid or pia or both. In such, the cord is found in the sac where it usually adheres to the roof and sometimes terminates in it. (Cases I, II, and XII.) This type is called the myelomeningocele. The surface of such a tumor may or may not be entirely covered with epithelium—a granulating area or several—may exist along its summit, and the same thin pearl-gray coat seen in the myelocele is sometimes found. It is not usual but it does happen, that the normal skin may cover a tumor of this type, *i e*, a cystic tumor containing the cord. The cord is not always attached to the roof, but may lie free in the sac.

A structure much resembling cord in gross appearance, except that it has no nerve roots attached to it, is sometimes seen in this form of tumor. One end of it is attached to the cord, the other to the roof of the sac, which it causes to dimple in. It has been found in the dorsal region (Case VII), and in the lumbosacral region (Case X). When found in the lumbosacral variety, it may contain a canal continuous with that of the spinal cord and open out on the roof so as *to look like* a myelocele. These processes were first noticed by Forster. On section they are found to contain nervous tissue toward the inner end, and skin elements toward the outer—or they may retain the nervous elements throughout. Those found along the continuity of the cord are probably remains of the fused but unabsorbed walls of the neural groove at that level. Those occurring as a continuation of the cord represent the lower coccygeal segments of the embryonic cord which should have remained only as the filum terminale. If such a process is canalized throughout, cerebrospinal fluid is discharged at the summit of the tumor. This and

the surface appearance may give rise to the diagnosis of myelocoele with refusal of operation—a serious mistake

When the cord is attached to the roof in any way, traction is made on the cord as the column lengthens. This may produce paralyses of various kinds although cord and nerves are quite normally developed

Syringomyelocoele, the form wherein the tumor is due to the protrusion of a portion of the cord distended by the accumulation of fluid within the spinal canal at that level, I have not yet seen

The simple protrusion of meninges—meningocoele—in which the defect is one of development of the arches of the vertebræ, offers no difficulty. They are usually entirely covered with normal skin and pedunculated. Usually not more than two arches are involved. I do not believe it is possible to be certain it is merely a meningocoele until the sac is opened

Von Recklinghausen insisted that in every spina bifida there existed a dural defect. This has been so in ours, but there has always been more than enough dura to close the defect

When the abnormality presents a trough-like depression covered with what looks like mucosa or granulation tissue, and from the centre of which clear fluid wells up, one cannot be certain that this is a myelocoele, and the reddish area, the opened-out cord (See Case XI) This is an important fact and not generally known, hence, I repeat it. When, however, such a tumor appears above the lower lumbar region, I believe the diagnosis of myelocoele is warranted

A dimpling of the surface of the tumor is strong evidence of the presence of the cord within the sac, but it is not a certain sign thereof. Nor is the observance by transillumination of cord-like structure within the sac a certain diagnostic sign. One must look inside to be certain

But it is not the presence alone of the cord which is important, rather is it the extent and cause of the accompanying paralysis which concern us most. The paralysis may involve only one muscle group or a part of a group—it is often total paraplegia. It is a flaccid paralysis. The uninvolved muscles draw the joints into abnormal positions. Thus, club-foot, dislocated hip, *etc*, may be produced. One should test for sensory paralyses as well, they usually co-exist

As has been said, various paralyses may exist even though the cord be normally developed and what looks like a myelocoele may be unaccompanied by paralysis (Case XI) The pressure or traction of abnormal bands or strands of arachnoid may be sufficient to prevent normal cord function. That this is so in spina bifida occulta, no one any longer denies

How then is one to determine the cause of an existing paralysis? In order to make a correct prognosis the cause of the paralysis must be known

It seems to me that (excepting the myelocoeles above the lower lumbar region) there is no known certain way of determining the cause of a paralysis in the presence of a closed sac—the surgeon must first see the interior of such a sac and examine the cord, nerves and membranes



A properly developed cord may not function because of traction, *etc*. Such a cord carefully released and restored to its bed may possibly function normally. I have found no well-authenticated case, but improvement has been noted. But an "opened-out" cord in the roof of the sac is another matter. Such a cord is not normally developed and the operation for its replacement in the canal (it can be successfully accomplished, see Cases IV, V and IX) must necessarily traumatize it and still more curtail its function. Therefore, to expect to benefit an existing paralysis by operation in the case of myelocoele, plane or cystic, is a vain hope.

A paralysis of both legs or of one may be a great handicap. None the less, one may live a very worthwhile, and even a happy life, whether viewed from his own standpoint or that of his associates.

A paralysis of bowel and bladder, however, that causes incontinence of faeces and urine, is a far different condition. This practically condemns the patient to a life of ostracism which begins when he reaches school age and lasts the remainder of his life. Paralysis of both sphincters—anal and vesical—may occur with only very slight paralysis elsewhere (Case I). It is conceivable that they alone may be paralyzed.

The absence of the anal reflex is a constant clinical sign of paralysis of the anal sphincter, but the reflex may be absent because of sensory paralysis alone. However, a paralyzed sphincter gapes and has a loose feel to the examining finger.

No one, so far as I can learn, has yet reported a single case wherein a congenital paralysis of bowel or bladder was cured by operation for spina bifida. The history of Case II would seem to contradict this, but it will be seen that although the statement is made that "the bowel moves constantly," it is also stated that "anal reflex is present." This child still has a weak sphincter, but has not incontinence—and I think he never had.

Coffey has done a great deal toward the perfection of a technic for the successful transplantation of the ureters into the bowel. Such an operation in the presence of a paralyzed sphincter and would likely not improve the patient's condition.

For a paralyzed anal sphincter alone, a sigmoidostomy properly performed ameliorates the condition of the patient. Unfortunately, in spina bifida the paralysis of sphincter and is not likely to occur without accompanying vesical paralysis. In such a case a sigmoidostomy following or followed by caecal or sigmoid implantation of ureters would probably not improve matters.

For a paralyzed vesical sphincter alone, however, Coffey's operation seems to be the best so far developed.

In spina bifida, to operate or not to operate is the question one must decide. Will it be better under all circumstances to operate than to leave the case to nature?

What will happen to those left unoperated upon? The patient with spina bifida of the myelocoele or myelocystocoele variety, if left alone, will most likely soon die. If there is leakage of cerebrospinal fluid, meningitis

will soon ensue. When the covering of the sac of a meningocele is thin, it very likely will become ruptured as soon as the child begins to creep about, if not before.

The patient having meningocele covered with normal skin may grow up to adult life. One was exhibited some years ago before the St. Louis Medical Society by Doctor Jonas. Such a thing is not common.

In 1913, Froelich came to the conclusion that the operative mortality was so high (64 per cent in his study) it was better to counsel non-interference, as he found it only 29 per cent in the non-operated. Cutler (1924) reports sixty-five operations on selected cases at the Children's Hospital, Boston, and found the mortality to be 47.65 per cent. Moore collected and studied all the cases on file in the Surgeon General's index from 1813 to 1905. The average mortality of the operated cases—385—was 27 per cent. He found the mortality 35 per cent for those in the first months, but in those of five years or more the mortality was 47 per cent. Harrar (1916) reported thirty-four cases with sixteen deaths (47 per cent). Romanis and Mitchner (1929) advise that "cases which seem on the point of rupturing should be operated upon at once—others are best left alone." Homans gives 50 per cent as the mortality. My own experience is that if the case comes to the *proper kind* of operation *early enough*, the question of operative mortality can be ignored entirely.

The presence of hydrocephalus is said to contra-indicate operation. There were three which showed signs of the condition. Since operation, one of these has died of it (Case IX), one is alert mentally, but hydrocephalic (Case V) and one we could not trace (Case XII).

It is my opinion that any case not having vesical and rectal paralysis should be operated upon. I also believe that the best time to operate is as soon as one can get the baby. Babies under three days—or even a week old—do not shock so much as when they are older. Furthermore, the head-down position is still natural to most of them, and it is to be maintained for some length of time.

There are many different types of operation. I believe that there are certain details which make for low mortality.

The position of the patient during operation and afterward I regard as of the utmost importance. Abbe, in 1893, was the first to stress this point. Von Bergmann, in 1899, emphasized it, saying that he always operated with the child's head well down lest sudden change in the intracranial tension interfere with brain metabolism. He also kept the child on its side with the head low afterward—"on no account must the position be changed." W. Babcock has also urged its importance.

I feel sure the loss of even a little spinal fluid at operation or afterward might easily cause death in certain cases. Not only have all those reported here been operated upon in this position (Fig. 1) but all have been kept in this position for at least six days—for at least two days after cerebrospinal fluid has stopped draining.

Prevention of contamination both during and after operation, I feel, is helped somewhat by the rubber dam of Eastman. He sewed it to the skin. I have applied it with rubber cement and it is kept on for days. Von Bergmann covered all with collodion dressing.

The length or duration of the operation is important. Nothing should be done that is not necessary. The first step should be an incision into the sac. This is for the purpose of making the diagnosis exact and complete. Such incision should be longitudinal, near the anterior end of the tumor, and 1.5 to 2 centimetres from the mid-line. This will not injure cord nor nerve roots. After opening the sac one can quickly determine the site of cord or nerves if either be present. In further progress of the operation

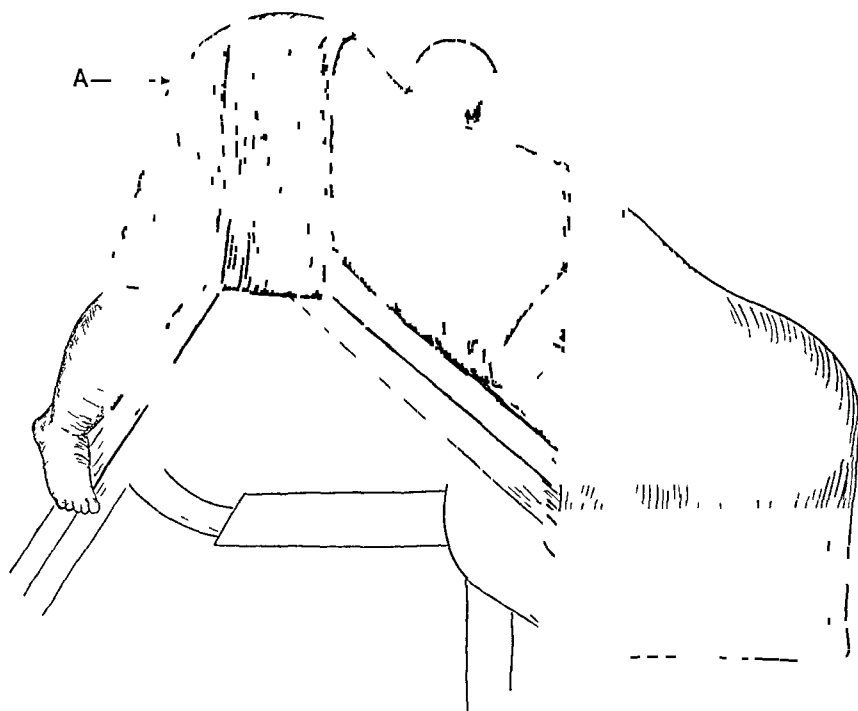


FIG 1.—Position during operation and for some days afterwards. A—Rubber sheet fastened to the skin with rubber cement.

he now knows at least where not to cut. If nerves pierce the sac wall they course through the tissue between skin and sac on their way to their respective foramina of escape, and may be cut if one is not aware of this. I do not know whether it would make any difference if they were cut.

An elliptical incision (Harmer), its long axis transverse, is the kind I prefer. It is just of such a width as will conserve as much as possible of the normal skin to facilitate closure. It has the advantages that, when closed the deep and superficial sutures are not in the same plane, and leakage of cerebrospinal fluid is not so likely, and also the edges are better supplied with blood than are those of a vertical incision. Beginning at the angles, the skin and fat are carefully reflected until the pedicle or base of the sac is reached (Fig 3), taking especial care when exposing the caudal aspect of

this, that nerves leaving the sac are not severed. The redundant part of the sac is cut away, leaving just enough so that closure may be without tension. The cord may have its tip (Cases I and II) or a portion of its dorsal aspect, or the filum terminale (Case XI) adherent to the roof. If such is the case, and the cord be normal, a careful separation of the overlying covering—it may be but a thin layer of squamous epithelium—must be made. Obviously, it will not do to return epiderm to the canal with the cord. The embryonal remnants (?) found in Cases VII and X were at first sight thought to be cord and were attached to both cord and roof of sac.

If the cord be "open" and forming part of the wall of the sac, it is possible of successful restoration to its bed, although Keiller and others deny this (Cases IV, V, and IX). The "raw" surface must be sterilized and, if epithelium covers it, this must be removed. One must bear in mind, however, that most likely this cannot be done without further injuring what is practically always a defectively developed cord. I have sterilized such a spot with the actual cautery (Cases IV and V) but it causes too much destruction. Later I sterilized the surface with 1 per cent mercurochrome twice daily for several days previously (Case IX), then shaved off a thin layer under a stream of saline, using a very sharp knife. The surface has never bled seriously. When cord and nerves have been returned to the canal and the redundant sac cut away, the sac is closed transversely with a continuous plain No. 00 catgut suture—"serosa to serosa." This suture line is less likely to adhere to the cord if it is transverse.

Some have advised reconstruction of the bony canal. Osteoplastic flaps have been raised from the ilium and from the spine itself—Dollinger, von Bayer, Bobroff, Hildebrand, *et al*. Such procedure lengthens the operation, increases the trauma and produces much shock, and when completed is unnecessary. The cases do quite well with a simple turning of a flap of the lumbar fascia, and some do as well without any flap at all (Case I). I use the double flap of von Bayer cut as shown in Fig. 4, and turned backward and inward, one falling over the other—one suture is enough to hold them.

The closure of the wound is then made transversely. When the defect is very large, an incision is made across the back parallel with the upper edge of the defect, of equal length with it and at least three inches from it (Fig. 5). The skin and underlying fat between the defect and this incision are now carefully raised up from the deep fascia. This gives a flap attached at both ends—flap of Celsus (?)—which slides easily down and is sutured to the lower edge of the defect. It is sometimes necessary to make the parallel incision longer at each end, so that the flap can be brought down without tension. One can gain something by undercutting the lower edge of the defect, but I try to manage so as to have the superficial suture line well below that of the closed sac. The upper wound is now a defect, which is allowed to heal by granulation, dusting it with bismuth subiodide powder and laying a piece of rubber dam or oiled silk on it.



FIG. 3—The skin and fat are lifted up from the edges toward the centre, taking care to avoid cutting nerves that lie on the outside of the pedicle. They are sometimes found below and laterally.

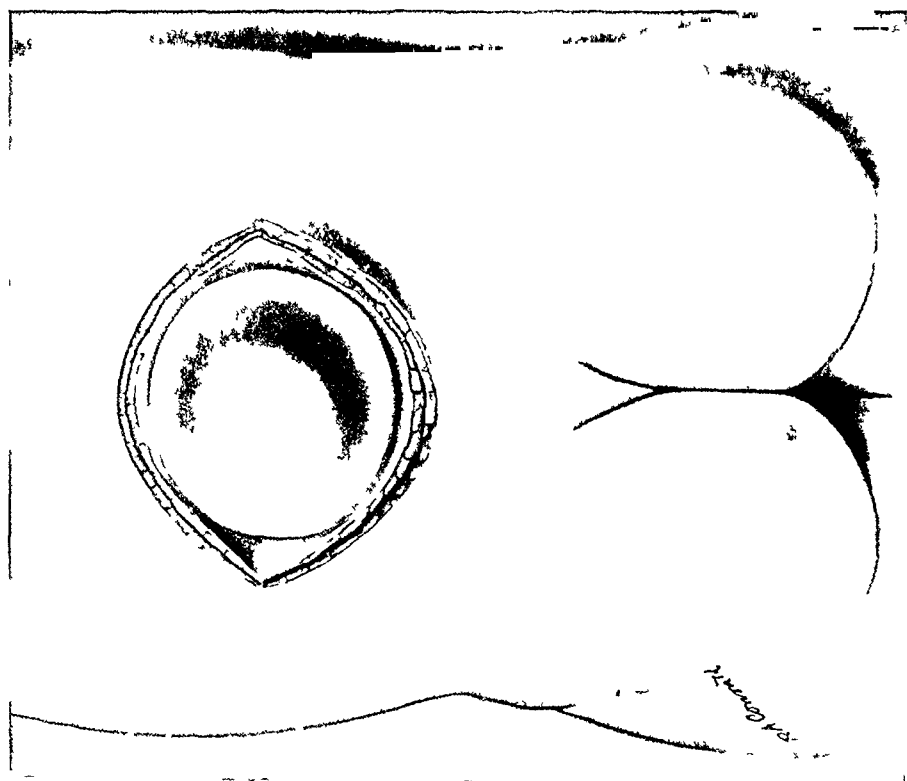


FIG. 2—The tumor is excised transversely saving as much of the normal skin as possible. The artist has made the long axis relatively too short.

## SPINA BIFIDA

The patient is kept constantly in the head-down position for the next six or seven days. The wound is dressed daily and the sutures carefully inspected and removed at the first sign of irritation. If closed without tension on the suture line, healing will be firm within a week. In no case does cerebrospinal fluid escape through the suture line, but it is not unusual for it to escape under the flap up toward the defect—not much, after the first week.

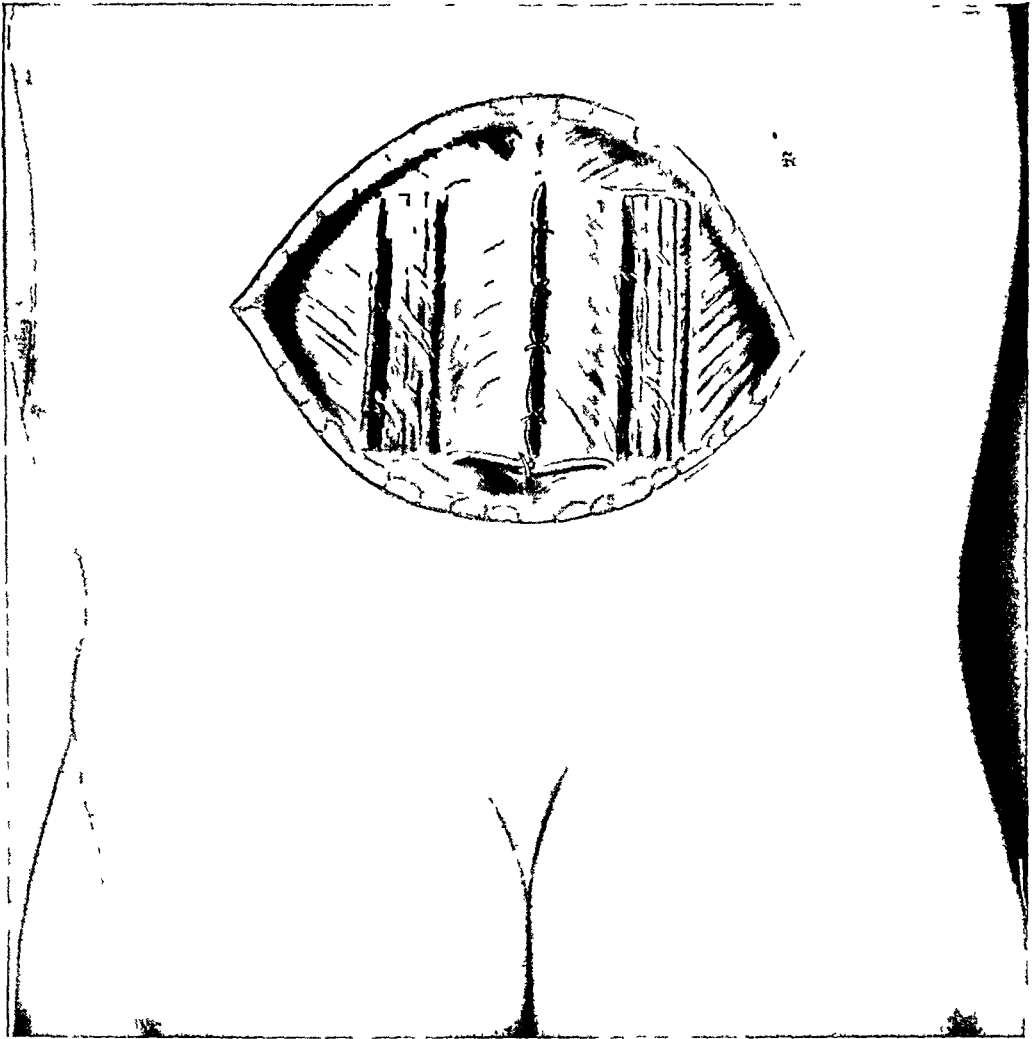


FIG. 4—Two flaps of lumbar fascia, of appropriate length and width, the base of each toward the mid line and close to the defect, are turned over backwards, the one to overlap the other. One suture is enough to hold them together.

In none of the cases have I made any attempt to construct an osteoplastic flap and in none is there a recurrence of the condition.

CASE I—St John's Hospital, Gen No 406, admitted November 8, 1920. Referred by Dr K C Spain. An apparently healthy boy two days old. The parents are healthy Americans of English stock. There are four other children in the family, all normal and healthy. No history of any deformities in the family. No history of lues. Wassermann, negative.

There is a tumor in the mid-line of the back in the lumbar region, just above the sacrum. It is somewhat hemispherical in shape and about 5 by 4 by 2 centimetres. It is

"dimpled" at the summit, and from the edge of the dimple through a small opening, clear fluid is exuding drop by drop. The tumor, for one-third the distance from this dimple to the base, is covered with a thin, pinkish-gray, dry membrane which is continuous with the normal skin, which covers the lower two-thirds of the tumor.

Doctor Spain informed me that at delivery, the tumor was tense and glistening and that there then was no leakage, and that twelve hours later the sac was leaking and wrinkled instead of tense. When first seen by me, the day before operation, the tumor was only moderately distended, its surface was soiled with recent feces, and the clear fluid referred to was issuing from the opening at the edge of the dimple at the rate of about twenty drops per minute. The dimpled or puckered part had an ulcerated or raw appearance. There is an increased redness in the pinkish pellicle at the edge of the opening and the exudate on the raw surface looks like pus. When the baby cries the tumor increases in size, and the fluid flows faster. Feces and urine escape from time to time. The anus seems open—it is certainly not drawn in and puckered in the normal way. The limbs are kept in strong flexion, and the baby seems to move them voluntarily.

Operation was performed when the child was approximately sixty-six hours old. The baby was held in face-down, head-down position, its feet and legs drawn downward over the end of the table, so that the axis of the body was at about forty-five or fifty degrees with the horizon, and the axis of the thighs at right angles (or less) with that of the body. Ether was given on the open mask. The field was sterilized with half-strength tincture of iodine, removed with 95 per cent alcohol. The Percy cautery at a black heat was lightly applied to the edge of the opening in the pellicle, and to the raw surface in the dimple, and again tincture of iodine was applied over the burned area, and round about over the tumor.

The tumor was removed by a transverse excision, elliptical, cutting through the skin covering the tumor half-way between summit and base. Sac and skin attached to it were removed. Some nerves were cut, as they lay imbedded in the sac wall. The cord was attached near its end to the dimple in the summit of the sac, and on cutting it free, it bled rather freely from a single vessel. This was ligated, and the opening in the dura (?) closed transversely, serosa to serosa, with continuous plain No. 00 catgut.

The defect was about two inches wide at its middle. A transverse incision was made through skin and subcutaneous fat about three inches above the defect. The intervening skin and fat flap was now lifted up—as in Fig. 5—and the flap was slid downward and sutured to the lower edge of defect with interrupted silkworm gut and continuous No. 00 plain catgut (epidermal) sutures. The defect left above was dusted with bismuth subiodide powder and covered with a rubber strip. A dry dressing was applied over all. There was lost only what cerebrospinal fluid the sac contained, and the baby was in splendid condition.

The orders were to feed as usual and keep baby constantly in the position maintained during operation, to give paregoric for crying or restlessness.

The recovery was uneventful. November 20 the last sutures and dressings were removed, and November 21 the child was removed from the hospital.

The discharge note says the bowel does not move as often as before operation, and there is no bulging—there was no fascia flap used in this case. The leg movements were as before operation.

The further history is that at about the age of one year the feet were noticed to be in talipes varus position, and orthopædic appliances have been used more or less constantly ever since. At present, the child, now eight years old, is well grown for his age, and seems far above average intelligence. There is no sign of hydrocephalus, vision, hearing, speech and intellectual processes are excellent, nor is there any bulging at the site of the operation. The feet are in equino varus, the left in first and the right in

## SPINA BIFIDA

about second degree. However, he gets around lively enough, and without fatigue or pain, except when wearing the appliances, consequently, he wears these only rarely.

There is absolutely no control of either bowel or bladder, he wears oil cloth or rubber "bathing trunks" which, clinging tightly to the skin of the thigh, prevent the escape of urine and feces. He cannot go to school, as "he needs attention too often," his father says.

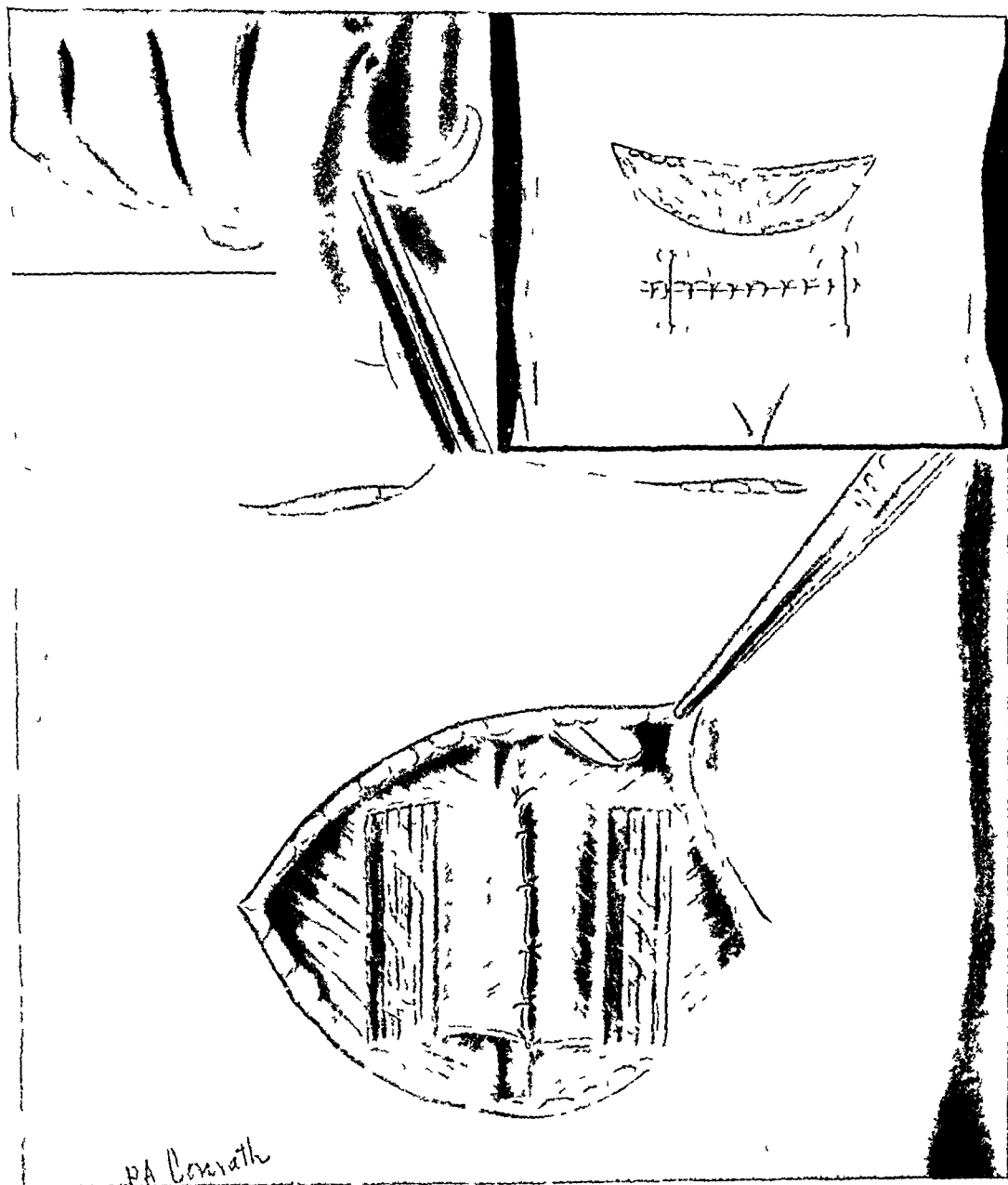


FIG 5—The defect is closed by a flap. An incision is made through the skin and fat at least three inches above the defect. The intervening flap is raised up and the upper incision is lengthened as much as is necessary to allow the wound to be closed without tension. The defect is now above. It is allowed to heal by granulation, is dusted with bismuth subiodide powder and covered with a bit of rubber. Some cerebrospinal fluid is likely to be discharged during the first few days. Insert illustrates the final closure.

When I visualize this child grown to manhood with this condition unchanged, I wish I had never operated on him.

CASE II—St John's Hospital, Gen No 2764, admitted June 13, 1921. A healthy boy baby, five days old, American, first baby, no history of deformities in either side of



family There is a tumor in the mid-line of the back, in lumbosacral region, almost hemispherical, about half the size of a large lemon, elevated three-fourths to one inch above level of surrounding surface It is covered with normal skin for only about one-fourth inch above its base, the covering here changes from skin to a thin, pinkish, semi-transparent pellicle At the summit is a spot from which the epithelium is missing, and which is covered with a scab or crust The tumor has a translucency somewhat like that of apple jelly, and in the depths in the upper left quadrant and in the mid-line, are pinkish-white opaque masses On pressing the tumor, the pellicle dimples but fontanelle does not bulge, nor does baby seem to be distressed However, when the fontanelle is pressed upon, bulging can be felt in the tumor Anal reflex is present, bowel moves constantly There is no paralysis in lowers No hydrocephalus

*Impression—Meningomyelocele* With the idea of avoiding rupture of the thin-walled sac with ensuing meningitis, operation was undertaken at once

Under ether on the open mask, the surface was sterilized, the raw surface at the summit was touched with the cautery and slightly charred A transverse elliptical excision through normal skin at base of tumor, cutting the skin and fat only Reflected skin and fat upward from all around, till sac was exposed Opening sac, we found the cord and a mass of nerve roots rather "bunched up" and attached to the roof under the charred area The sac was cut away, removing a thin layer of cord tissue along with it As much as possible of the neck of the sac was left (all that was covered by normal skin) The roots and end of cord were pushed forward into the open canal The spot on end of cord, where it had been cut free from the roof (in the bottom of the dimple referred to) bled freely A small vessel was ligated, and the cord and nerve roots dropped back in the open canal Two flaps of lumbar fascia, one on each side the opening in the canal, their bases toward the mid-line, were lifted up and turned over backward The sac was so thin and the opening so wide that no attempt was made to close it separately, but it was included in each flap The flaps were turned over backward and easily overlapped by about 15 centimetre The external wound was closed transversely, making a transverse incision through skin and fat, three inches above, and undercutting to relieve tension and allow sliding

Examination of the sac removed showed that where the cord had been cut from it, there was a whitish, hard area (on the inner surface of sac) This was less than one centimetre in diameter, and appeared to be made up of two symmetrical halves Microscopic examination by Dr R L Thompson "The material at summit of sac is nervous tissue and appears to be a part of the cord, the central canal of which is widely dilated Fusion of the dura with this can be made out No nerves appear in the section"

The child made an uneventful recovery In 1923, the following note was made "The baby's body is very large, the head is large and the brow projects There is lateral nystagmus, both eyes Pupils are equal and react to light The baby seems of normal intelligence It has not yet learned to walk alone There is spasticity of both legs, increased on attempts to stand The right foot is smaller No club-feet There is no bulging at the site of scar There is a well-marked 'post-anal dimple about one and one-half inches from the anus There seems to be incontinence of urine—the diaper is constantly wet The skin about buttocks and perineum is red and it looks red and raw, with flat warts growing abundantly everywhere It does not bleed when rubbed or washed, nor does it seem tender This is said to have first begun during an attack of diarrhoea when the child was one year old" He was sent to the orthopædist

The child was examined by me in July, 1930 At the site of the tumor there is no bulging whatever There is a distinct pulse feelable on palpation Halfway between the scar and the anus is a dimple On the under aspect of either buttocks, where patient sits, the skin has a peculiar scar-like appearance—no condylomata There is a thickening of the skin of the scrotum, and it has a peculiar, hypertrophied appearance The

child can lift its legs and move them. There is a certain amount of spasticity in the legs. They are not well developed. He has both flexion and extension of knees and hips. There is valgus of both feet but not marked. He has sensation in legs—can feel heat, cold and pin pricks. He is healthy, happy and intelligent. Walking with crutches. Has spastic lowers, certain tendency to "scissor-legs". Has acquired a certain amount of control over bladder—urimates at regular intervals. Never soils clothing by rectal discharges unless he has diarrhoea.

*Comment*—This was a meningocele. No defect of cord, and before operation anal reflex was present, although the bowel seemed to be moving constantly. Left to himself after operation, this would have been a wheel-chair case, but the orthopaedist—Dr A. E. Horwitz—has done a great deal.

CASE III—St John's Hospital, Gen. No. 7631, admitted August 2, 1922. An apparently healthy girl baby, four days old, weight seven pounds, normal delivery. Three other children in family all living and well. Has no other deformity, nor is there any family history of such. Baby nurses well. Seems to move limbs normally and the bowel and bladder seem normal.

There is a tumor in the mid-line of the back, just below the occiput against which it touches. It is spherical and about three inches in diameter, attached by a pedicle one and one-half to two inches in diameter to the middle of the back of the neck. The pedicle and the proximal half of the tumor are covered with normal skin. The remainder of the tumor is covered with a thin, grayish-pink membrane, in which ramify many large and small veins. In the left inferior quadrant this membrane bulges as a sort of diverticulum. The mass transmits light throughout, but is opaque. It does not appreciably tighten when the baby cries, but pressure on it seems to raise the tension at the anterior fontanelle.

*Operation*—August 2, 1922. The baby was given ether on the open mask and anaesthetized in the usual head-down position. Iodine-alcohol sterilization. Transverse, elliptical incision, crossing the sac through normal skin just below its junction with the thin pedicle mentioned. Withdrew twenty cubic centimetres fluid (cerebrospinal fluid) from sac to relieve tension. Incision carefully deepened and flaps lifted up from ends of ellipse toward mid-line until sac and pedicle were encountered. When the sac was held up tight, the pedicle measured about three-fourths of an inch across. The muscles were dissected well back from pedicle until bone was encountered. Two clamps were applied transversely, and the pedicle was cut between them. Very little cerebrospinal fluid was lost besides what was in the sac.

The neck of the sac was closed (serosa to serosa) by transverse, continuous suture—No. 1 plain catgut. A flap two inches by one and one-half inches was made on either side, their bases close to the pedicle. They were thought to be of trapezius aponeurosis. These were turned over backwards covering the pedicle, and the edge of one overlapping the edge of the other. They were sewn to each other with mattress-silk sutures, and, after making good hæmostasis, the skin was closed with slight undercutting and sliding. No drain.

The convalescence was uneventful. There was nothing to indicate any trauma to cord or spinal nerves.

On gross examination the interior of the sac showed, here and there in its wall, small recesses, and one of these, larger than the other (referred to above) was in the left inferior quadrant. There were no nerve roots visible, yet the microscopic examination of a section from the sac near its base shows 'nervous tissue present'.

Present condition, as reported by Doctor Clithero, is that the child has developed normally, is very intelligent and has no paralysis and no sign of hydrocephalus.

CASE IV—St John's Hospital, Gen No 11222, admitted June 7, 1923 A girl baby three weeks old Three other children in family, all normal No history of deformities in family

There is a tumor in the mid-line of the back, about the lumbosacral region The tumor is hemispherical, about two inches in diameter The normal skin mounts on the sides of the tumor for about one inch, and then gives way to a thin, bluish-white, shiny membrane, which is continued to the summit There is a raw, granulating area on the summit, a little more to the right, about  $1\frac{1}{2}$  centimetres by 1 centimetre, and clear, watery fluid is coming out of the tumor at the upper edge of this area The raw area is covered with a grayish mucous matter The tumor bulges when the baby cries  
*Impression*—Cystic myelocele

The anus is gaping wide open, the mucosa is everted about the edge, and seems gathered in little lumps There is no anal reflex and faeces are expelled from time to time The legs and feet look normal, and baby moves them apparently normally

The parents were informed that, left to itself, the child would most likely soon die of meningitis, that if the child lived it would probably lack control over the bowel whether operated upon or not They decided to have the operation performed

*Operation*—June 7, 1923 The skin was sterilized with half-strength tincture of iodine which was washed off with 95 per cent alcohol The operation was done in the usual position, body at an angle of forty-five degrees, head down—lowers hanging down, buttocks up—ether given on the open mask The raw granular surface was cauterized and about fifteen cubic centimetres of slightly turbid fluid were aspirated A transverse elliptical excision was made through the normal skin, saving as much of this as possible above and below Dissection was made from the outer ends of the ellipse toward the mid-line, lifting skin and subcutaneous fat until the pedicle of the sac was encountered The sac was opened to the right of the mid-line, cephalad to the raw area The cord and cauda seemed to attach themselves to the roof under the raw area The sac was opened in the mid-line below the raw area and the most of the nerves were seen to end in the summit of the sac The pedicle of the sac was cut through transversely, leaving enough to close The nerves and cord (?) were cut from their termination in the sac and returned to the open canal

The opening in the dura was closed transversely, and a flap turned up from fascia on either side, their bases toward each other, one on each side of the opening The opening in the column was one inch vertically and three-fourths inches transversely, each flap about two inches long by one and one-fourth inches wide They were turned over until one lay over the other, closing the canal They were sewed together with plain No 0 catgut A transverse incision, three and one-half to four inches long, was made through the skin and subcutaneous fat about three inches above the upper margin of the defect The skin and fat between this incision and the defect were undercut, and the Celsus flap thus made was slid downward and sutured to the lower margin of the defect with interrupted silk worm gut, epidermal approximation with continuous fine "dermal" suture The defect left by sliding the flap was sprinkled with bismuth subiodide powder and a dry dressing applied

The baby was kept in the head-down, face-down position with lower limbs hanging down over a pillow for the next ten days The spinal fluid Wassermann was negative June 10, 1923—The baby seemed drowsy and there was a purulent discharge from wound Some of the sutures were removed June 12, 1923—The baby was better Culture taken June 10, 1923 showed *Bacillus coli* The further course was uneventful and the baby left the hospital June 27, 1923

The present condition of the child as reported by the physician in charge, Dr J H Cochran, of Gideon, Missouri, is "The child is living and well There is no control whatever over bowel or bladder A diaper is worn constantly The child is above the average intelligence There is a moderate talipes calcaneus, but she walks pretty well

One eye is crossed There have been no ulcers on buttocks, legs or feet, and sensation seems normal"

*Comment*—In this case the incontinence was positively diagnosed before the operation The anus was gaping and there was no anal reflex The surprising thing is that there was no paralysis of limbs produced by the operation The raw area was sterilized with the cautery

CASE V—St John's Hospital, Gen No 11541, admitted July 4, 1923 A girl baby, one day old, first baby, no history of deformity of any kind

There is a cyst-like tumor mass in the mid-line in the lumbar region It is about one and one-half inches in transverse diameter and a little longer in the vertical It is about two centimetres in height The surface at its base is skin of purplish color which extends to skin over sacrum, and here there is a growth of black hair and a dimple in the mid-line lower down The skin ascends around the tumor almost half way to its summit, and here is replaced by what looks like thin scar tissue which is continued to the flattened summit where it ceases around the margin of a moist, raw, weeping area, one and one-half by two centimetres, of yellowish-brown, granular appearance The tumor contains fluid—but not under tension as the covering of the tumor wrinkles somewhat—no fluid escaping There is a dimple in the mid-line half way between the lower margin of the tumor and the anus *Impression*—Cystic myelocoele

The anus is everted, there is no anal reflex, the urine dribbles It moves the lower limbs, but these are not drawn up on the abdomen

*Operation*—The child was placed in the usual position, the field sterilized with half-strength tincture of iodine, which was removed with alcohol after four minutes The buttocks and anus were then excluded from the field with a rubber-dam sheet cemented to the skin above the buttocks—Eastman A cautery was lightly applied to the granular surface The sac was opened just lateral to the granular area, a small amount of cerebrospinal fluid escaped The sac was clipped away from around the margin of the granular area This was the dorsal aspect of the lower end of the cord Nerves could be seen streaming from the sides of this and passing into the ventro-lateral and inferior aspects of the anterior walls of the cavity, it seemed as though the spinal canal had become superficial to the spine The sac was then excised in transverse ellipse and while dissecting toward its base or "pedicle" from below, nerves were encountered emerging from it and apparently passing in the subcutaneous tissue over the back of the sacrum Some, while still in the wall of the sac, were accidentally cut Enough of the sac (dura?) was left to cover the cord and nerves, and two rather generous flaps were lifted from over the erectores spinæ so that no pressure should be made by them when united over the cord The usual flap (of Celsus?) was made above and slid down to cover the site of operation

The child was kept in the head-down position for the next week The sutured wound healed by first intention, the convalescence was uneventful The condition of bladder and bowels remained unchanged, but there was no movement whatever of the legs What I considered peculiar was the fact that the central canal of the spine seemed to have become superficial or, rather, ended by becoming superficial, in the mid-lumbar region Whether the paralysis of the limbs was completed by cauterizing the raw area or by accidentally cutting roots (some were cut), I do not know It was not likely due to the pressure of the flaps, as these were loosely applied and paralysis appeared immediately

At present, I am informed by the family doctor, the child is alive and well, alert mentally, but has marked hydrocephalus and is totally paralyzed in both lower limbs, rectum and bladder

*Comment*—It will be noticed that in many of the histories the statement is made that the sac wrinkles or does not bulge when the baby cries, as though there were not direct continuity with the general subarachnoid space, the defective area walled in, as it were. This is interesting when we remember that as late as 1885 a commission appointed in England agreed that the best results were to be expected from treatment by injection of iodine, *etc*

CASE VI—St John's Hospital, Gen No 12315, admitted September 7, 1923. Girl baby, seven days old. Father and mother had always been healthy. No history of any kind of deformity in family of either. One other child five and one-half years old, healthy. The mother had been "badly shaken up" in an auto accident during the sixth month of this pregnancy. The child does not move its legs. They hang flaccid when child is held up. There is a tumor, oval in shape, in the mid-line of the back. Its upper edge is just about the last ribs. Its long axis is vertical, about two inches long, and it is about one and one-half inches wide in its widest part. It is dark red or purple in color, is raised about one inch above the level of the back. It is covered with a very thin pellicle which is translucent and through which fluid can be seen. At its summit is a depression, also oval, with long axis vertical, nearly two centimetres long and half as wide. The floor of this dimple or depression seems pulled in, is yellowish-red and granular, and is not covered by the pellicle covering the tumor elsewhere. Nor is this floor translucent as the pellicle is. In the mid-line in the bottom of the depressed granular area, and rather nearer its upper end, is a tiny orifice from which a clear fluid wells slowly up. The upper edge of the depressed area comes to within one centimetre of the upper edge of the tumor and between these points in the mid-line, a structure thought to be the cord is visible through the thin covering in the translucent depths of the cyst-like tumor. There is no anal reflex. The anus has a loose, open appearance and urine dribbles from the vulva from time to time.

Confident that the condition was a cystic myelocoele and owing to the fact that there was paralysis of limbs and sphincters, operation was advised against, but was agreed to at the urgent request of the parents who felt they were morally obliged to make an effort to save the child. In sterilizing the raw area by the cautery in a case which seemed somewhat similar in appearance to this (Case V), there is no doubt the paralysis of the legs was made worse. I therefore decided to use tincture of iodine—3% per cent—and after three minutes to wash this off with alcohol, and then to slice away a very thin layer of the raw surface from above downward under a stream of saline.

*Operation*—September 7, 1923. The baby was placed in the head-down position and anesthetized with ether given on the open mask. The sterilization was carried out as planned. The sac was opened in the mid-line above the depression and the cord was seen to emerge, normal in appearance, from the canal above and to terminate by attaching itself to the roof of the sac at the bottom of the depression, and, flattening itself out strap-like, it formed the roof of the sac in the bottom of the depressed area. Opening the sac in the mid-line below the depressed area, no cord could be seen but many strands identified as nerves and filum streamed from the under surface of the depressed area. None of the nerves followed or adhered to the lateral walls of the cyst, but all were traced forward toward the longitudinal hollow which we took to be the open spinal canal.

The cyst wall was cut away from the edge of the granular area. It was very thin but not so weak as one would expect. A transverse excision of the sac was now made just as close to the edges above and below as permitted by normal skin. Beginning at the ends of the ellipse, the skin with the subcutaneous tissue was dissected up each side toward the central longitudinal furrow until the membranes coming out of the canal were encountered. This membrane—dura?—was now followed into the wall of the cyst. On either side a good flap of it was obtained. There was very little bleeding

and only such cerebrospinal fluid as was contained in the cyst was lost. A flap of lumbar fascia two inches long and wide as the erector spinæ was now raised from without inward on either side. The flaps at their bases blended with the flaps of dura. The dura flaps were overlapped and sewed together with interrupted mattress plain No 0 catgut sutures. The fascial flaps were now turned backward till one overlapped the other and these also were matted together. A transverse incision was now made through skin and subcutaneous tissue about three inches from the upper edge of the defect, and the skin and fat between this incision and the defect were lifted up. Circulation in the flap was good, and the defect was closed by sliding this flap downward and suturing it to the skin at the lower edge of the defect. Subiodide of bismuth powder was sprinkled over the bare area and dry dressing applied. There was no shock. The baby was placed in bed in the same head-down position and fastened so. There was no leakage of cerebrospinal fluid. September 19 the child was discharged. The flap had healed in place. The defect was healing. There was total paralysis of limbs and sphincters. The baby thrived at home for a while, and then grew weak and developed gastro-intestinal symptoms and is reported to have died of malnutrition eight weeks after operation. It did not develop hydrocephalus.

CASE VII—St Mary's Infirmary, Reg No 56959, admitted January 31, 1925. Boy, seven weeks old. There is a hemispherical tumor three inches in diameter and about one and one-half inches in height, in the mid-line of the back, in the mid-dorsal region. The skin of the back covers its sides half-way to the summit, and here changes to a thin, semi-transparent, bluish-white pellicle in which dilated venules can be seen, and through which can be seen fluid somewhat translucent. At the summit the pellicle covering it is drawn in like a puckered dimple. It enlarges perceptibly when the baby cries. The tumor is said to have appeared some days after birth, and at first was thought by the physician to be a lipoma. The skin covering it was at first whitish, but has since become bluish. The X-ray failed to show the defect in the spine, although on palpation a distinct bony ring-like margin could be felt at the base. Because of the puckering or drawing inward of the skin at the summit, I expected to find some portion of the cord in the sac—meningomyelocele. The child was fretful and cried a great deal, but temperature was normal. There were no palsies noted. There were four other children and all normal, and both parents were quite sure there had never been any deformities on either side.

*Operation*—January 31, 1925. Ether. A transverse excision was done preserving as much normal skin as possible. The sac was opened in the mid-line half way to the summit before excising it. A structure about the size and shape of the baby cord was seen emerging from the canal, and which, proceeding to the summit of the sac, attached itself there at the site of the dimple mentioned. It could not be seen re-entering the canal, and although so high up (mid-dorsal), it was feared that there was a possibility of its being cord. The baby was allowed to revive from the anæsthetic, and it moved its legs freely even when I handled this process. Its tip was now carefully separated from the sac, and while doing this, the process broke, leaving a free portion attached to sac lining. On removing and sectioning it, we found it to be a cyst one centimetre in diameter and containing "cheesy" matter. Microscopic sections later showed "a skin-like structure with hyperplasia of sweat glands." The proximal fragment was removed, flush with the cord, and sections from this show "ganglion and glia cells."

The sac was cut away, leaving enough of the pedicle to close easily. No transplantation of fascia flaps was done, and the edges of the skin closed by undercutting and sliding. The child made an uneventful recovery. *Present condition*—The child seems perfectly normal. There is a bulging at the site of operation, partly reducible. The skin slips over it. There is a hard mass about 1 to 1.5 centimetre at its edge that seems to be connected with the spine. The mass seems to have a pedicle.

*Comment*—The interesting thing about this case was the peculiar cord-like process reaching from within the canal and attached to the roof of the

sac That its inner end should resemble the structure of the central nervous system and its outer that of the skin is, of course, what one might have expected, since the deep portion of the sulcus vertebralis forms the central nervous system The process found in the sac, I take it, was a complete cross-section of the lateral walls of the sulcus vertebralis, which remained unabsorbed Perhaps, in fact, this unabsorbed remnant was the cause of the spina bifida, but why it was not absorbed has not yet been told

CASE VIII—St Mary's Infirmary, Reg No 57195, admitted March 17, 1925 A healthy male, sixteen hours old There were five other children all living and well No deformities on either parent's side of the family There are no paralyses of any kind There is an enormous, somewhat spherical tumor attached by a pedicle to the mid-line of the back The pedicle reaches from about lumbar 3 to sacral 3 (about two and one-half inches) The tumor is covered with dusky red skin, and many large veins can be seen on its surface It is moderately tense, fluctuates on test, and seems to contain fluid It is translucent throughout It is quite five inches in diameter Compression causes bulging of the fontanelle No paralyses Meningocele It was decided to operate at once

*Operation*—The usual position, ether anæsthetic The cyst was punctured and 625 cubic centimetres of cerebrospinal fluid were slowly withdrawn before the sac was empty The sac was opened on its summit and a still further (estimated at thirty cubic centimetres) amount escaped A transverse elliptical incision was made, including the pedicle The skin was reflected and the pedicle exposed Looking into the sac through the incision in its summit, one could see nerves lying in the open spinal canal at the bottom of the sac Some of them were doubled up or folded upon themselves and some penetrated the pedicle wall below, escaping from the sac into the superficial tissue behind the sacrum The pedicle was cut long enough so that its edges would a little more than meet each other in the mid-line They were sewed together with continuous plain No 1 catgut Two flaps of fascia were now elevated (see Fig 4), turned backward till one overlay the other, and sutured in this position with interrupted mattress sutures of No 0 twenty-day catgut Skin closed by sliding (Fig 5)

By mistake the sutures were removed too soon and on the sixth day the wound reopened in the mid-line However, by careful dressing and using 2 per cent mercuriochrome freely and continuing the head-down position, infection was kept out and by April 12, 1925, the child was taken home completely well The child at present is perfectly normal No sign of hydrocephalus

*Comment*—While this is an example of meningocele, and although it was entirely covered with normal skin, it was of such a size that it most surely would soon have become traumatized or ulcerated Nothing was to be gained by waiting and it is very well known by all who have had much experience with operations on babies that there is very little shock after operations done during the first hours of life

CASE IX—St Mary's Infirmary, Reg No 60432, admitted November 10, 1926 A female baby, seventeen days old Seems healthy Has a rather large head—hydrocephalic?—but no bulging of fontanelles The baby was normal delivery, full term, eight pounds There is a tumor in the mid-line, in upper lumbar region It is about three inches in diameter, circular in outline, and about one and one-fourth inches in height The skin covering it is of a peculiar, purplish-red, and ascends half way to the summit, where it gives place to a thin, gray-white membrane Along the mid-line at the summit over an area about 1.5 by 2.5 centimetres there is no epithelial covering The surface here is granular and red in color and from this surface, occasionally, a drop of clear fluid comes No opening can be seen Pressure over the tumor is not felt over fon-

tanelles—cystic myelocoele? The left lower limb has hung blue and paralyzed since birth. The right lower limb does not hang quite so lifeless and baby flexes right thigh occasionally. The sphincter ani appears to be normal. The mother's blood gives Wassermann test positive ++++.

It has been stated that hydrocephalus is a contra-indication to operation, but here was a child whose sphincters seemed normal, one entirely paralyzed and one partially paralyzed lower limb, whose head—while a trifle large—was not altogether hydrocephalic. It was decided to operate.

*Operation*—November 19, 1926. For eight days a 1 per cent mercurochrome was applied twice daily to the granular area. When we had the baby in the operating position, I painted the tumor and the field with half-strength tincture of iodine, this was removed with alcohol. Two per cent mercurochrome was used to paint the granular area. With a sharp scalpel, I pared away the superficial layer of the granular area, working under a stream of saline at 104° Fahrenheit.

The incisions were now made above and below so as to remove the mass by transverse, elliptical excision, and saving just as much skin as possible. The tumor was freed to its pedicle all around. The sac was now opened to the right side of the granular area. This, as suspected, was the dorsal aspect of the cord. The sac wall was cut free from the cord all around the granular area referred to. No nerve roots ran in the sac wall, they could be seen disappearing into the shallow canal in the bottom of the sac. Enough of the pedicle was left to cover over the canal. The flaps of fascia were raised and turned back as usual, and the wound was closed with the Celsus flap in the usual way. The child recovered without incident, but was given active antiluetic treatment the while. After four days, we noticed movement in the left leg and it no longer "hung lifeless." There was also more motion in the right. The improvement was very marked at the time of the discharge of the patient. The sphincters continued normal. The hydrocephalus became more evident. In a month it was quite marked. Antiluetic medication failed to arrest its progress and the child died March 14, 1927.

*CASE X*—St. Mary's Hospital, Reg. No. 27331, admitted September 21, 1927. A white boy baby, seven months old. There has been a tumor in the lower lumbar region since birth, but at the age of five months, the child developed whooping cough, and since then the tumor has been getting larger and discharging. The child was a normal delivery, and has been breast fed and is quite healthy and bright. There is no history of any kind of defect or deformity in the family. There are no paralyses of limbs or sphincters. There is a hemispherical tumor in the mid-line of the back, in the lower lumbar region. It is 6.5 centimetres in diameter and has an elevation of 5 centimetres. Its sides are covered with normal-looking skin. On the summit are two somewhat deep depressions. One in the mid-line below is funnel-shaped and its floor is lined with a pinkish granular surface which bleeds easily, and from its centre comes a clear, watery fluid. The second depression in the summit is 2 centimetres cephalad to the first, and 2 centimetres to the left. At the right edge of this depression, is what looks like a granulating surface 2 centimetres long by 1 centimetre wide, and from this comes clear fluid. The covering of the summit of the tumor is a thin, semitranslucent membrane, bluish-pink in color and is tense in spite of the fact that fluid is escaping. There are no paralyses. It was thought to be a cystic myelocoele.

*Operation*—September 22, 1927. Under ether with the baby in the usual position, a transverse excision of the tumor was made. The incisions were made across the tumor, so as to retain all of the normal skin possible. The dissection was then made around the tumor so as to isolate the lower half of the tumor and its pedicle. The sac was now opened on its summit to the right of the mid-line, and its fluid contents—clear and watery—estimated at 100 cubic centimetres, escaped. The interior of the sac looked not unlike the inner surface of the normal dura. The bottom of the sac disappeared in the spinal canal, and, issuing from the canal, was seen a structure which looked like the end of the cord devoid of nerve roots and covered with a web-like membrane. This



structure was attached to the roof of the sac, under the funnel-shaped dimple in the mid-line, previously mentioned. The cord-like structure was cut free from the roof, and turned back into the spinal canal. It was necessary to remove the vertebral arch below the pedicle of the sac in order to do this without squeezing or crushing it. The pedicle of the sac was left just long enough so that its serous surfaces could be apposed in vertical mid-line closure. Two flaps of lumbar fascia, bases toward each other and as close as possible to edge of bony defect, and long enough to cover the defect, were turned over backward, one to overlap the other and close the defect. The usual sliding closure was then made. The recovery was uneventful and the child is at present quite normal in all respects.

*Comment*—In this case cerebrospinal fluid (?) had been escaping from the tumor for at least two months and yet the child remained quite well. Other such are recorded by Fincham and Hoon. The structure projecting which "looked like the end of the cord devoid of nerves" perhaps should have been removed. Section through the roof at the place where this structure had been detached showed "Tissue covered by squamous epithelium. The sub-epithelial tissue consists of granulation tissue, richly infiltrated with leucocytes and older hyalinized fibrous tissue. There are many lymph spaces which vary much in size and shape. (Arachnoid?)"

In my opinion, this is exactly the same sort of structure as that encountered in Case VII—namely, an unabsorbed "rest" derived from the walls of the neural groove. In this case it was found at the extreme end of the cord instead of in the mid-dorsal region, and more than likely was the filum terminale still canalized.

CASE XI—St. Mary's Hospital, Reg. No. 281359, admitted April 3, 1928. A girl baby, well formed except for an abnormality in the lower part of mid-line of back, which consists of two portions, an upper hemispherical portion raised up to the extent of three-quarters of an inch and being about one and one-half inches in diameter. Attached to this and extending down from it, is a V-shaped trough, base formed by the above-mentioned tumor and apex extending to within two inches of anus. The V-shaped portion continues up and ends in a depression or dimple on the lower half of the tumor. This depressed, triangular area is red and glistening, looks like a congested mucous membrane, and from it is discharging clear fluid. The tumor is bluish-white. Its covering is a thin pellicle, semi-translucent. It becomes tense when the baby cries, also, the fluid flows more freely from the area when the baby cries. Between the tip of the reddish, triangular area and the anus, there is a deep depression (dimple) in the mid-line. The baby moves all of its limbs normally. There is no anal reflex. The baby voids urine from time to time, and although the anus has a loose feel, the bowel moves at intervals of perhaps three or four hours.

*Operation*—April 3, 1928. The day before operation, the part was painted every three hours with 2 per cent mercurochrome and kept covered with sterile gauze which was not allowed to become soiled. The preparation for operation consisted in painting the field with half-strength tincture of iodine. This was removed with alcohol. Iodine was not applied to the raw surface but 2 per cent mercurochrome was used instead. Then with a sharp knife, while the baby was held in the head-down position, beginning at the highest point of the raw area, the surface of the raw area was pared away under a stream of sterile saline. A very thin area was removed as is sometimes done in preparation for a skin graft. The tumor was incised and its interior inspected. It contained cerebrospinal fluid which escaped, when a mass could be seen apparently com-

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ing out of the canal of the spine and ending in the roof of the sac in the mid-line under the dimple already described. No nerves were seen. This structure was separated from the roof and returned to the canal. The hemispherical tumor mass was excised transversely and the triangular mucous surface was excised. This portion of the defect was closed vertically. The elliptical defect left after excision of the hemispherical tumor was closed by undercutting and making a flap in the usual way. The baby bore the operation very well and could move its legs as well after operation as before.

Nothing abnormal was noticed until the third day, when suddenly the legs became oedematous and petechial areas appeared around the upper thighs and lower abdomen especially in front. At the same time, the baby did not take its food very greedily.

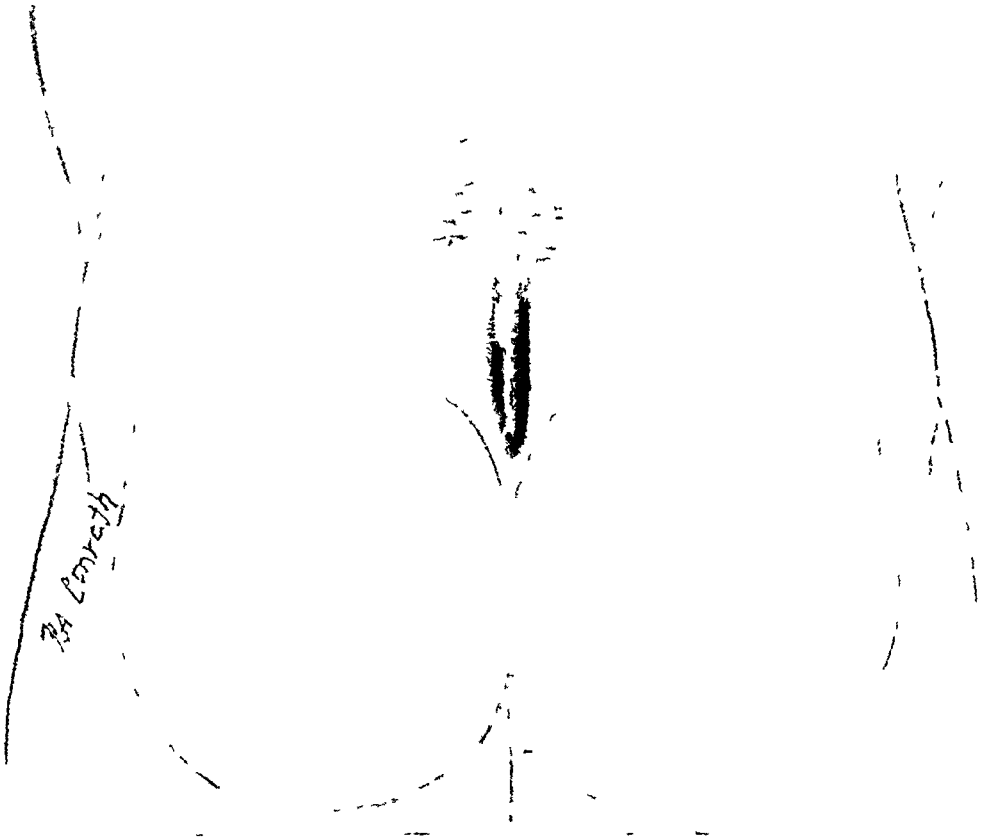


FIG 6—Case XI. A diagnosis of myelocoele was made. Notice that the trough like reddened area extends low down. Clear fluid came from the bottom of it. At operation a structure which looked like the end of the cord minus nerve roots, was found attached to the red area. The specimen has been lost. In all probability it was a persistent and open filum terminale.

and on the seventh post-operative day refused food entirely. The abdomen became distended. At this time the thighs were cyanotic. The baby cried a good deal. The pædiatrists were lavaging the stomach and doing their best to find a formula that would agree. Spinal fluid was discharging in moderate quantities (through the defect above) up until the seventh day, but the wounds were healing. Nothing abnormal was noticed about urine or bowel movements. The baby was being treated by lavage and gavage from the eleventh until the fifteenth, on which day there was no urine or defecation. Emesis began on the sixteenth. On this day also there was no bowel movement and no urine. On April 17 the patient died, fourteenth post-operative day.

The striking feature was the swelling of the lower limbs which had begun on the third post-operative day and grew worse until death. The first week the patient

was kept in the head-down position, but when cerebrospinal fluid no longer discharged, it was lowered to normal and lay on either side or abdomen

A partial post-mortem was obtained and revealed a diffuse, foul-smelling general peritonitis, the cause of which was not determined, but there was a distended bladder with gangrenous cystitis, and at one point the bladder wall was so thin that fibrin was laid down on the peritoneum at this point (posterior superior surface) Cultures were made but were lost on the way to the laboratory

CASE XII—St Mary's Infirmary, Reg No 63201, admitted June 4, 1928 A girl baby, ten months old Since birth the feet have been "clubbed" (varus), and baby has not moved her legs properly The child seems normal mentally The head is large The eye movements are normal and "the fundi show slight venous engorgement, and the disc edges are not clear" (Doctor Hardesty, ophthalmologist) The child can flex thighs on the abdomen Asleep, she lies on the right side with thighs almost at a right angle with the body, and knees in extension She can slowly move the right knee and foot slightly, but the whole left lower limb is paralyzed Response to pin prick and light touch is negative in the left leg and thigh, and seems less than normal in the right The sphincters are incontinent The anus gapes The baby's color is good, and it is well nourished There is a tumor, somewhat hemispherical, in the mid-line of the back in the mid-lumbar region It is about 5 centimetres by 5 centimetres, and is elevated about  $\frac{3}{4}$  centimetre Its surface looks like scar tissue, and is much furrowed The skin covering the summit is bluish and thin-looking The tumor has a lumpy feel, is compressible, but not reducible, becomes tense when the child cries, but does not pulsate A few coarse hairs are seen around its base An X-ray of the spine reveals a defect in the third and fourth lumbar vertebral arches There is a slight enlargement of the skull and convolutional impressions are deepened The other three children in the family are healthy The Wassermann (cerebrospinal fluid) is positive

*Operation*—June 4, 1928 A transverse excision removing an ellipse of skin with the tumor in the centre (See Fig 2) The pedicle of the sac was left long enough so that its edges could be approximated in a vertical suture The pedicle is thick and fibrous, and is about one inch in vertical, and slightly less in transverse diameter The sac contains clear fluid and a fibrous, cord-like structure—*filum terminale*?—issues from the canal and joins the roof of the sac in the mid-line below the centre of the summit Neither cord nor nerves were seen There was a quantity of peculiar, fibro-fatty tissue outside the pedicle The sac was cut away and the opening was closed by suturing the pedicle edges together vertically and then two flaps were raised from the lumbar aponeurosis, and turned over backward, the edge of one made to overlap that of the other The skin and subcutaneous tissue closed in the usual way by sliding down a flap from above The child made an uneventful recovery, and was discharged July 5, 1928

Present condition unknown

*Comment*—This child seemed to acquire more use of its legs after the operation, but I could not be entirely sure whether the movements were voluntary or reflex There was no recovery in the sphincters The mentality remained bright, and the child seemed quite well in other respects

#### SUMMARY

The records of all the author's cases up to 1929 are given—twelve cases There was one operative death(?) The child developed cystitis and peritonitis and died on the fourteenth day

The ages varied from sixteen hours to seven months There were seven females and five males

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There were five myeloceles, four meningo-myeloceles, and three meningo-celes Eight "open" (discharging cerebrospinal fluid) and four were closed

Five showed sphincteric paralyses before operation The same has not been benefited by operation Six (including the above five) have had more or less paralyses in the extremities In one there was thought to be improvement after operation In one the paralysis was made worse

Three were markedly hydrocephalic—one died in four months, one is alive and alert, seven years old No child has developed hydrocephalus since operation

Eight of the twelve are living and well, three are dead, and one could not be traced

The author is of the opinion

1 That by rigidly following the technic outlined, the operative mortality should be *nil*

2 That an open sac alone is no contra-indication to operation

3 That the diagnosis of myelocoele does not always contra-indicate operation The diagnosis may be wrong when the defect is in the lumbosacral region

4 That a total paralysis of the sphincters, in the presence of a myelocoele, is a distinct contra-indication to operation

5 That in meningo-myelocoele the only way to be certain with regard to the presence of the cord in the sac is to open and look within it

6 That the children under four days old stand the operation best

7 That there is no need to make any kind of osteoplastic reconstruction of the spinal canal

8 That paralyses with certain cases of meningo-myelocoele are improved by operation

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## BRILLIANT GREEN

A CLINICAL STUDY OF ITS VALUE AS A LOCAL ANTISEPTIC

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FROM THE NORWEGIAN AMERICAN AND LUTHERAN MEMORIAL HOSPITALS

AN IDEAL local antiseptic must meet several requirements and possess the following properties

1 Great inhibitory power toward pathogenic microorganisms, at least those which are most important and most frequently encountered in common surgical diseases, this antiseptic property must be exhibited not only *in vitro* but also *in vivo*, i. e. in the presence of serum

2 Rapidity of action, in order to prevent spreading of infection

3 Sufficient penetrating power

4 No deleterious effects on phagocytosis, products of glandular secretion, hormones and other defensive processes of the organism

5 Absence of irritating effects, even after repeated applications upon the tissues of the host, including delicate and sensitive structures such as mucous membranes

6 No interference with or a stimulating effect upon reparation processes of the organism, particularly formation of granulation tissue

7 Low toxicity in case of absorption

Generally speaking the local antiseptics can be divided into two groups (1) Those which are not irritating and injurious to the tissues but have an extremely low germicidal action (2) Those which are powerful disinfectants but at the same time damage the tissues. Their action as irritants arises from the same qualities as their bactericidal or bacteriostatic power, namely from general toxicity to the living matter

Certain objectionable characteristics confine the justifiable application of most of the popular antiseptics to within narrow limits. For instance, acriflavin has won favor because of its penetrating action and the length of its activity, but it is not a particularly rapidly acting antiseptic. This fact lessens its value for prophylactic treatment of potentially infected wounds. Hexyl-resorcinol gave growth of bacteria in all tests carried out by Raisiss and Severac<sup>1</sup>. Tincture of iodine has the disadvantage of causing irritation of the skin in many patients, particularly if wet compresses have to be applied after painting with iodine. Tinker and Sutton<sup>2</sup> found that iodine, trinitrophenol, Harrington's mercuric chloride solution, mercuriochrome—220 soluble—and potassium mercuric iodide will not kill most of the resistant bacteria and some of the less resistant pathogenic bacteria under conditions of perfect contact.

It is exceedingly difficult to estimate the value of an antiseptic in the

prevention or treatment of septic processes because the innumerable bacteriological tests at our disposal are all subject to criticism, hence the reports are confusing and contradicting. Practically speaking, the only method to judge an antiseptic, after its bactericidal action has been ascertained in preliminary antiseptic and toxicity tests, is to evaluate the clinical results obtained and to compare them with results observed after use of other known disinfectants.

The fact that new antiseptics and germicides make their appearance in the literature and on the market serves as best proof that most of the substances in general use fall short of the ideal in their therapeutic action. The popularity of some of the newer antiseptics is not based entirely upon their merits but is due partially to the wide publicity and undiscerning enthusiastic reports.

On the other hand, some valuable old antiseptics have been overlooked or fallen into misuse either because they have not been made the subject of extensive clinical studies or because they did not represent products of high commercial value. One of the most powerful among such antiseptics is brilliant green. The bacteriostatic action of certain dyes on bacteria was observed as early as 1887. Browning, *et al*<sup>3</sup> recommended the use of brilliant green in 1917, they found that the substance is particularly destructive to the cocci group but toward bacterium coli its bactericidal value is considerably lower. Krumwiede and Pratt<sup>4</sup> found that the inhibition of growth by brilliant green has been most evident among the Gram-positive bacteria, the paratyphoid enteritidis types are more resistant. Ligat<sup>5</sup> reported very satisfactory results with brilliant green. Peterson<sup>6</sup> studied the comparative merits of various antiseptics by recording their inhibiting effect upon the yeast-sugar mixture. The method consists in determining the smallest quantity of drug that will prevent the formation of gas in a yeast-sugar mixture of definite strength during a period of one hour. Whereas the inhibitory amount of metaphen in grams was 0.0017 and that of mercurochrome 0.065, the amount of gentian violet was only 0.0039, crystal violet 0.0024 and methyl violet 0.0051. These figures show that the above-mentioned aniline dyes possess a much stronger inhibitory power than mercurochrome and compare very favorably with metaphen. Another dye, however, is still superior to these aniline dyes as far as bactericidal action is concerned and this is brilliant green as shown by the experiments carried out by Norton and Davis<sup>7</sup> who determined the bacteriostatic action of dyes on streptococcus viridans and pneumococci. They state that brilliant green is the most active dye they found, as evidenced from the following part of their protocol:

Dye	Slightest dilution giving complete inhibition
Brilliant green	200,000
Gentian violet	40,000
Methylene blue	25,000
Methyl violet	10,000

According to their statement to have a marked bacteriostatic action, a dye must contain three benzol rings and two or more amino-groups in which the

hydrogen atoms have been substituted by alkyl radicals. In most instances this alkyl radical is the methyl group but in brilliant green ethyl groups are present.

Disregarding the excellent qualifications, brilliant green has fallen into oblivion and the interest in it was revived by Doctor Baccal,<sup>8, 9</sup> the scientific collaborator of the surgical clinic of the State Institute of Odessa. He limited his report to general statements as to the great value of brilliant green in minor surgery, pre-operative preparation of the skin, sterilization of hands, catgut and surgical instruments and treatment of burns and certain external eye diseases, such as blepharitis.

In view of the above-mentioned laboratory experiments and favorable clinical reports by Browning, Ligat, Baccal and others, a further investigation of the qualities of brilliant green seemed to be justified. The present study was limited to evaluation of brilliant green as a local antiseptic.

Brilliant green chemically is a diamino-triphenylmethane compound. The product is a green powder, soluble in water and alcohol, the aqueous solution is not stable and should be freshly prepared, it has been used by me only for warm baths and compresses. Otherwise a 1 per cent solution in 60 per cent alcohol was used in all the cases except mucous membranes where 0.5 per cent solution seemed to be more advisable. The stains on hands can be removed by vigorous rubbing with alcohol or hydrogen peroxide, the latter can be used to remove stains from soiled linen, but usually the ordinary washing processes are sufficient.

As space prevents a detailed report of all cases treated, a brief résumé shall be made of the clinical results obtained. The treatment was either prophylactic or therapeutic.

*A Prophylactic Treatment with Brilliant Green—1 Pre-operative Preparation of the Skin in Minor Surgery*—Unless exceptionally dirty when a preliminary washing with soap and water was necessary, no preparation of the skin except painting with 1 per cent brilliant green solution was made in order to form a better judgment as to the antiseptic power of the product. Operations were performed for such conditions as subcutaneous lipomas, fibromas, cystomas of the tendon sheaths, sebaceous cysts, phimosis, etc. In infants 0.5 solution was used instead of 1 per cent solution. The results obtained in this group were very satisfactory. In the whole series of ninety-three cases there was not a single occurrence of infection. The great susceptibility of the tendon sheaths to infection is well known, nevertheless in seven cases of ganglion of the tendons no infection occurred. An irritation of the skin could not be observed in any of the above-mentioned cases.

*b Major Surgery*—After the favorable results obtained in the pre-operative treatment of minor cases, the use of brilliant green in major surgery seemed to be justified. After the routine preparation, consisting of washing with soap and water, followed by alcohol, a 1 per cent alcoholic solution of brilliant green was used for the pre-operative preparation of the skin in laparotomies for various conditions. The results were highly satisfactory.



No infections were observed which could be ascribed to the use of brilliant green. In one case a stitch abscess occurred which could be traced to contaminated catgut. Not in a single case in the series of 111 were there any indications of irritation of the skin, even when wet compresses had to be applied afterward. The use of brilliant green should be of special value in the pre-operative preparation of the skin for thyroidectomies where absorption of the tincture of iodine is feared. A 0.5 per cent solution was used on mucous membranes for hemorrhoidectomies, vaginal repairs, suturing of lacerated lips and similar conditions.

2 *Prophylactic Treatment* of potentially infected wounds and abrasions including minor injuries as well as extensive lacerations which came under treatment a very short time after injury and where no clinical signs of infection were yet present. There is no positive criterion to judge the efficiency of an antiseptic in such conditions and in forming an opinion one is guided by impressions rather than by definite figures. An opportunity presented itself, however, in a case of laceration of several fingers to investigate the comparative value of metaphen, mercurochrome and brilliant green. All seven injured fingers presented approximately the same degree of injury of soft parts and were equally contaminated with dirt and machine oil. The two wounds treated with metaphen showed no signs of infection and produced granulations of a pale pink color, the healing process was fairly rapid, three fingers treated with mercurochrome produced pus and showed brownish granulations of moderate size with very slow healing tendencies, in two fingers treated with brilliant green a rapid formation of exuberant, bright-red granulations could be observed which led to a scar formation more quickly than in the other fingers. Of course, such an experiment is not conclusive as to the relative value of various antiseptics as it may be argued that the degree of infection of each injured finger could not be exactly determined, nevertheless the striking results are in line with experiments of Browning, *et al.*,<sup>3</sup> who also observed in a large number of cases that brilliant green stimulates the formation of richly vascularized red granulations while with flavine the granulations were not so bulky and of pale color. No indications of tissue damage or irritation could be observed.

B *Therapeutic Treatment*—This category comprises 123 cases which already exhibited manifest infection when they presented themselves for treatment. This group comprises such spastic conditions as abscesses located in various parts of the body, including Bartholin's abscesses and post-operative stitch abscesses, acute suppurative bursitis, acute suppurative lymphadenitis, boils, carbuncles, phlegmons, cellulitis, fistulae resulting from osteomyelitis. In addition to the painting of the skin with brilliant green solution before the incision was made, the solution was also instilled into the wounds at each dressing. In a number of cases this treatment was supplemented by bathing the infected part in a warm aqueous solution of brilliant green 1:2000 and compresses of an aqueous solution 1:1000. In ischio-rectal and perianal abscesses the results appeared to be superior to mercuro-

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chrome but to an impartial eye they were not better than those obtained with acriflavine and especially with metaphen, the same observation was made in abscesses after appendectomies and in cold abscesses. This fact is probably due to the above-mentioned limitations of the bactericidal properties of brilliant green. As stated, this chemical is very efficient in all cocci infections but its antiseptic power is much smaller toward bacterium coli and tubercle bacilli. In the rest of the cases the results ranged from very satisfactory to excellent.

*Discussion*—The clinical results with brilliant green solution as local antiseptic showed that the product was efficient as a prophylactic measure against infection in the pre-operative preparation of the skin. In the treatment of infected wounds and various septic processes the impression was gained that the infection was more quickly brought under control, the granulations were more abundant and healthier and the healing process was more rapid than has been the author's experience with other antiseptics in general use. As to the toxicity, no ill effects following the use of this substance over prolonged periods of time could be observed. It is left to the genito-urinary specialists to decide whether a clinical trial with brilliant green in the treatment of gonorrhœa is desired. As to the intravenous injections, extensive laboratory experiments will be necessary. The use of brilliant green for sterilization of the hands of the surgeon as advocated by Baccal will hardly become popular in view of the staining properties of the substance. The attempt to use it in preparation of catgut may be justified although several manufacturers asserted to the author that there is no need for introduction of a new antiseptic in preparation of catgut as the present methods are satisfactory. A recent report by Meleney and Chatfield<sup>10</sup> shows that in a study of 174 specimens of catgut submitted by twelve surgical clinics, twenty-two or 12½ per cent were found to yield spore-forming bacteria including the common gas gangrene organisms. In this connection it may be interesting to note that according to Churchman<sup>11</sup> who studied the bacteriostatic action of gentian violet upon bacterium anthracis, the spores are at least gravely affected by treatment with the dye and that in presence of it they can not develop. As brilliant green has a higher bacteriostatic action than gentian violet, the use of it may be of value in preparation of catgut. A ¼ per cent ointment prepared by dissolving brilliant green in water and mixing it with petrolatum has been recommended by Baccal for treatment of burns.

### SUMMARY

A survey of the clinical results after the use of brilliant green as local antiseptic in prophylaxis as well as treatment of various surgical conditions shows that the substance possesses a high antiseptic value toward the most frequent pathogenic microorganisms encountered in surgical diseases, it has an excellent power of penetration, it is non-irritant and non-toxic, it stimulates the formation of healthy granulation tissues and, last but not least, it is

very cheap The impression was gained that in many instances the substance was superior to other antiseptics in common use These findings justify further clinical investigations as to the value of brilliant green and suggest the desirability of laboratory experiments in order to evaluate it as a general antiseptic

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# SOME INDICATIONS FOR SECTION OF THE POSTERIOR ROOT OF THE TRIGEMINAL NERVE THROUGH THE POSTERIOR FOSSA

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SECTION of the posterior root of the trigeminal nerve through the temporal fossa has, by most clinics, come to be accepted as the usual route for carrying out this measure. It is well standardized and carries about as low a mortality and morbidity as any operation in surgery. There are, however, a group of cases where it would seem to be well-nigh impossible or at least extremely difficult to section the posterior root of the fifth nerve in this usual manner. It seems worthwhile to report a group of such cases—five in number. Dandy<sup>1</sup> has called attention recently to the feasibility of sectioning the posterior root of the trigeminal nerve through the posterior fossa. This operation has been carried out in the five reported cases as well as in a number of others.

*CASE I—Trigeminal neuralgia, major—right. Section of posterior root of trigeminal nerve through posterior fossa because of an osteoma in the floor of the temporal fossa.* O H, hospital No 28,440, a thirty-nine-year-old woman, was referred to the hospital for the relief of major trigeminal neuralgia. The history was entirely typical of this malady and she was observed in several very characteristic attacks.

*Operation*—The floor of the middle fossa of the skull was exposed by a linear incision through the right temporal muscle and elevation of the dura was carried medially for about three centimetres. At this point there was a fairly marked elevation of the floor of the middle fossa which seemed unusual. It apparently was situated slightly anterior and lateral to the foramen spinosum. An attempt was made to locate the foramen spinosum and divide the middle meningeal artery, but this proved impossible owing to the fact that this bony prominence projected upward to the height of about one centimetre in front of the foramen. An attempt was made to chisel this bony prominence away, but mucous membrane of the nasal cavity was at once exposed. The dissection was carried forward until the first division was identified, but it was impossible to expose enough of the ganglion to extirpate it. Consequently the attempt was abandoned, and on the next day the posterior root of the right trigeminal nerve was divided through the posterior fossa without difficulty. The motor root could be identified slightly anterior and medianward to the sensory root and was preserved. No particular difficulty in bleeding was encountered from the petrosal veins. The patient made an uneventful recovery and has had complete relief of pain to date, some eighteen months later.

*CASE II—Basal-cell carcinoma of left cheek. Metastases to parotid gland and left temporal region. Section of trigeminal root through posterior fossa because of infection in temporal region.* J P, hospital No 26,048, was transferred to the neurosurgical service because of severe pain in the distribution of the left trigeminal nerve. He had been under treatment for over a year with a progressive basal-cell carcinoma.

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<sup>1</sup> Dandy, Walter E. An Operation for the Cure of Tic Douloureux. Partial Section of the Sensory Root at the Pons. Arch Surg, vol XVIII, p 687, 1929.

of the face. Metastases to the parotid gland and temporal region had occurred. Biopsy of a gland in the temporal region had been done, and at the time seen the field was slightly infected. Because of the presence of tumor in the operative field and also because of the presence of infection it was thought advisable to section the posterior root of the trigeminal nerve through the posterior fossa. This was carried out under novocaine and colonic ether anesthesia. There was some difficulty in exposing the trigeminal dorsal root owing to the fact that a large petrosal nerve lay directly over it and a small artery to the side of it. The artery was coagulated and divided. It was then possible to slip a hook beneath the vein and avulse the posterior root without damaging the motor division or tearing the petrosal vein. The patient had complete anesthesia in the distribution of the fifth nerve (Fig 1 and Fig 2).

CASE III—*Carcinoma of the jaw with cervical metastases. Section of the posterior root of trigeminal nerve through the posterior fossa in order to combine cervical dorsal rhizotomy with section of the root of the fifth nerve.* G. G., hospital No. 26,597, a

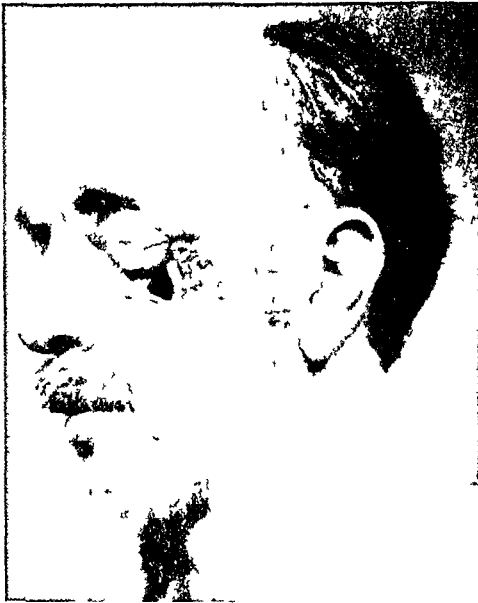


FIG 1

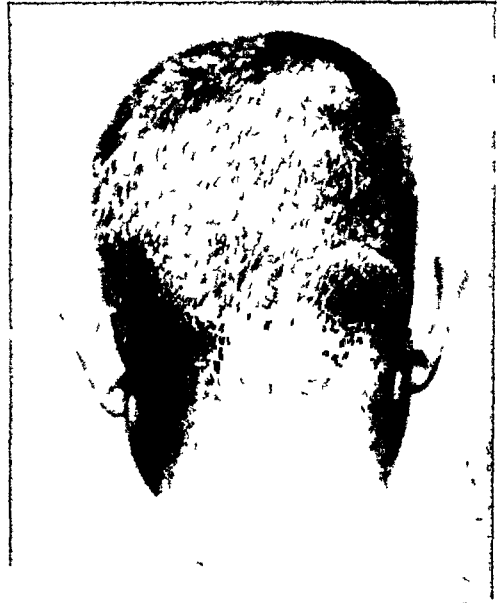


FIG 2

FIG 1—Case II. Basal cell carcinoma of face. Metastases to temporal region and parotid gland which base became infected following biopsy.

FIG 2—Case II. Type of incision used for unilateral cerebellar exposure and section of dorsal root of trigeminal nerve via posterior fossa.

forty-seven-year-old man, was transferred to the neurosurgical service because of severe pain from carcinoma of the right jaw with metastases to the floor of the mouth and cervical lymph-nodes. When first seen most of the pain was largely in the region of cervical metastases. A section of the cervical nerves as they appeared along the posterior border of the sternocleidomastoid muscle was done rather than an intradural dorsal-root section, because of his poor general condition. At the same time a ligation of the external carotid artery was carried out because of the danger of hemorrhage from ulcerations within the oral cavity. The patient obtained considerable relief from pain for about six months and was able to eat and sleep moderately well. At the end of this time, however, he had a recurrence of the pain both in the distribution of the cervical nerves and of the right trigeminal nerve. Opiates by this time had proven to be of little use and some more radical measure for relief of pain seemed warranted. Under colonic ether and local anesthesia, the right trigeminal nerve was exposed through the posterior fossa. There were two good-sized branches of the petrosal veins lying over

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the nerve. These were electrocoagulated and divided. Another branch passed so close to the posterior root that it was impossible to divide it, and consequently both vein and posterior root were coagulated together. The dorsal root was not actually divided. At the same time the upper four cervical nerves were exposed by a hemilaminectomy and divided.

Complete anaesthesia over the face and cervical region of the operated side resulted. The patient survived ten days following operation. Autopsy showed a carcinoma of the right side of the tongue, of the right jaw, and of the floor of the mouth. A bilateral necrotizing pneumonia and gangrene of the lungs with multiple small abscesses presumably followed aspiration from a much-infected oral cavity.

**CASE IV—Carcinoma of sphenoid sinus with extension to left Gasserian ganglion and basal dura mater.** Section of dorsal root of fifth nerve through posterior fossa. A. S., No. 31,209, a man aged fifty-seven, was referred to the neurosurgical service because of pain in distribution of the left fifth nerve. The patient obviously had Paget's disease

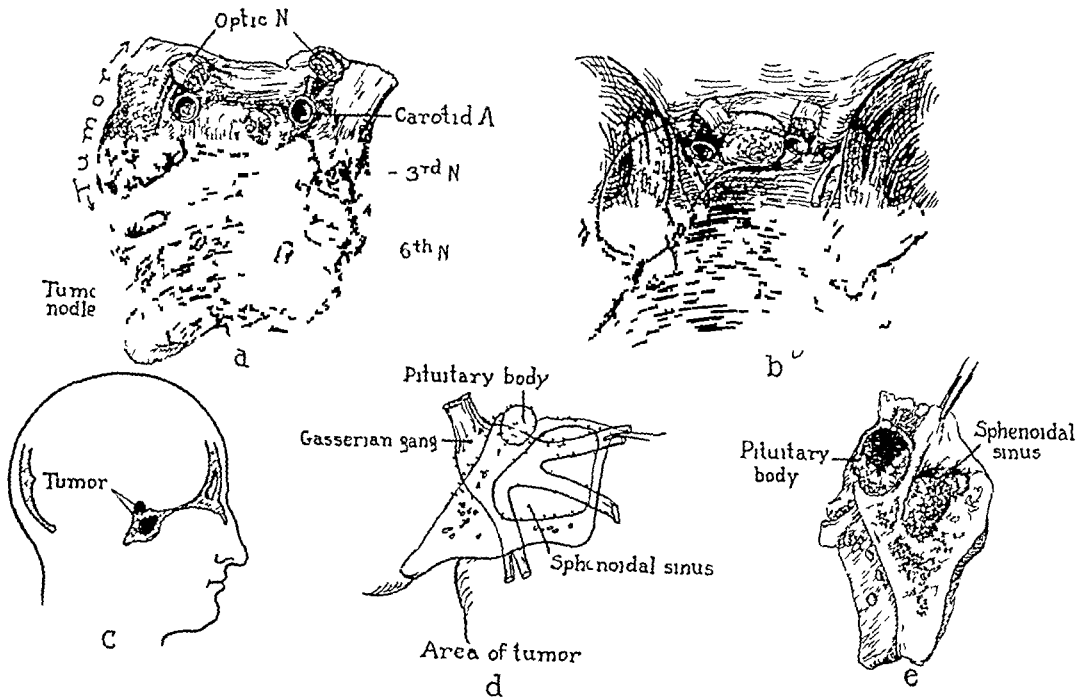


FIG. 3—Case IV. Drawing of autopsy specimen showing invasion of left Gasserian ganglion, pituitary body and dura mater over basilar bone by a carcinoma of the sphenoid sinus.

in a fairly advanced stage. X-rays of the skull showed the usual changes associated with Paget's disease. The possibility of bony exostoses about cranial nerve foramina as a cause of the third, fourth, fifth and sixth nerve palsies was considered. A tumor of the Gasserian ganglion was also thought likely because of ocular palsies and pain in fifth nerve distribution along with partial anaesthesia and partial motor paralysis of that nerve. No evidence of a tumor involving the nasal sinus could be demonstrated by X-ray, probably because of the marked changes in bone associated with Paget's disease.

An attempt was made to section the posterior root of the fifth nerve through the middle fossa. The middle meningeal artery was exposed without difficulty. When an attempt was made to push bone wax into the foramen spinosum to control bleeding, the bone proved to be so soft that it pushed away in front of an instrument with great ease. Troublesome bleeding from the artery resulted, and it was necessary to ligate the external carotid artery in the neck. The middle meningeal artery was then divided. It proved totally impossible to expose the posterior root of the trigeminal nerve owing to the presence of a tumor of fairly great vascularity involving the Gasserian ganglion. After repeated unsuccessful attempts to extirpate enough tumor to get at the posterior

root, each associated with fairly profuse bleeding, the wound was closed. Several days later the posterior root of the fifth nerve was divided through the posterior fossa. The patient succumbed some six days later. Autopsy revealed the presence of a small carcinoma of the sphenoid sinus with extension to the pituitary gland, sphenoid bone, left Gasserian ganglion, and the dura mater at the base of the skull (Fig 3). He also had moderate bilateral bronchopneumonia, arteriosclerotic kidney, healed pulmonary tuberculosis, and chronic, adhesive pleuritis. Changes in bone commonly associated with Paget's disease were everywhere evident.

*CASE V—Trigeminal neuralgia—major. Section of posterior root of trigeminal nerve through posterior fossa because of dense adhesions between dura mater and Gasserian ganglion.* R. H., a forty-one-year-old man, was referred to the hospital because of severe trigeminal neuralgia of some ten years' duration. He had had nine or ten "deep alcohol injections," only two of which had given any lasting benefit.

*Operation*—An attempted section of the dorsal root of the trigeminal nerve through the temporal fossa was made with the patient in the sitting posture. The middle meningeal artery was divided without difficulty. From this point on the dissection to uncover the dorsal root was extremely difficult. The dura was leather-like and so densely adherent to surrounding structures that it could not be elevated from over the dorsal root. The mandibular division of the ganglion and dura over it seemed fused. The ophthalmic division of the ganglion was then exposed and attempt made to uncover enough of the ganglion itself to either inject it or extirpate it. This also proved impossible. Presumably the previous stray alcohol injections had set up a profuse connective tissue reaction about the dura and surrounding structures.

Two days later the posterior root of the trigeminal nerve was exposed through the posterior fossa. The arachnoid about the nerve was much thickened and adherent to surrounding structures. Several fair-sized radicles of the petrosal veins gave troublesome bleeding and it was only after a long tedious procedure that the dorsal root was finally divided. The patient has had complete relief of pain but has had some persistent ataxia of one arm, presumably due to damage to the cerebellum in exposing the dorsal root and controlling bleeding.

The operative procedure has varied greatly in its technical difficulties. In three of the reported cases the trigeminal dorsal root was sectioned with comparative ease. In one case it was necessary to electrocoagulate the root along with a branch of the petrosal vein. The root could not be divided without a great likelihood of tearing the vein. On the other hand, complete anaesthesia and relief of pain followed such a procedure. In one case serious bleeding from a torn petrosal vein occurred and was controlled only with difficulty. Evidence of slight but permanent damage of the cerebellar lobe has resulted. In none of the cases has there resulted any injury to an adjoining nerve. The operation has been performed on five other patients where the dorsal root could have been sectioned through the temporal fossa. In two of these cases the root was only partially sectioned. In both of these cases the pain has been completely relieved. Sensory examination following this is in accord with that described by Dandy, *et al.*, there was a preservation of normal sensation over the distribution of the trigeminal nerve except for a small area about the upper lip in one instance and about the lower lip in another. The impression gained from these ten cases is that the operation is a procedure of considerably greater magnitude and risk than that through the temporal fossa. In spite of this, familiarity with the operation would

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seem to be a very valuable adjunct to one's neurosurgical armamentarium. Two deaths in the ten cases operated on have occurred. Both were in subjects much debilitated by far-advanced carcinoma and death might well have followed any major surgical procedure. There is a group of cases where the trigeminal root cannot be sectioned through the temporal fossa and for these it would seem to be largely indicated. There is a second though smaller group where it is at times advisable to combine an upper cervical dorsal rhizotomy with section of the trigeminal root. This may well be combined in one operation.

The emphasis that Dandy has laid on a very exacting equipment, such as suitable lighted retractors, nerve hooks and right-angle knives, right-angle silver clip holders, a smooth anaesthesia, *etc*, can only be stressed.

No difference in the type or distribution of sensory loss could be made out from that obtained by section of the dorsal root through the temporal fossa if the root was totally divided. In two cases where the dorsal root was partially divided there resulted a preservation of normal sensation over the greater part of the face. Preservation of the motor root has undoubtedly been easier and more assured by the posterior fossa route than by the temporal route.

### CONCLUSIONS

Five cases are reported where section of the posterior root of the trigeminal nerve was done for the relief of pain perforce of necessity. In one of these cases the operation was combined with a unilateral upper cervical dorsal rhizotomy. The impression is gained from these and other cases that while the operation is considerably more hazardous and difficult than that through the temporal route, it is a valuable adjunct to one's neurosurgical armamentarium. No evidence has been gained from this series of cases that the type or area of anaesthesia differs from that which occurs when the trigeminal root is sectioned via the temporal fossa, provided the root is totally divided. In two instances where only the lower half of the nerve was sectioned there has been a preservation of sensation over the face in all but several localized areas.



## PENETRATING WOUNDS OF THE ABDOMEN\*

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WE HAVE reviewed the records of 220 cases of penetrating wounds of the abdomen admitted to the Pennsylvania Hospital during the years 1909 to 1930 inclusive, and for the privilege of reporting them we are much indebted to Drs. John H. Gibbon and Charles F. Mitchell, surgeons-in-chief to the hospital, and to the former chiefs upon whose services they were admitted. We have not included in this series any cases with penetrating wounds other than those resulting from stab and gunshot injuries. We are considering the two groups separately because the stab wounds, as a group, are less serious than the gunshot cases for the reason that, in the latter, there is more hæmorrhage and more extensive visceral injury.

In this series, about the usual ratio of danger of the gunshot over the stab injuries was maintained, that is, a little more than 2 to 1. The operative mortality in civil life seems to have been established around the 50 per cent level for gunshot wounds and about 25 per cent for the stab injuries, with a considerably higher total rate for both groups. In the gunshot cases, Wallace, reporting on 1200 cases from the British Expeditionary Force, showed an operative mortality of 53.9 per cent, and a total mortality including non-operative cases of 60.2 per cent. Lockwood Kennedy, *et al* in military service, reported on 500 cases with an operative mortality of 51.97 per cent. In 1902 Foner reported on 152 cases of gunshot wounds from the Charity Hospital, New Orleans, 96 of which suffered visceral injury with 71 deaths (74 per cent). Bivings, in 66 cases operated upon, reported a mortality of 60.6 per cent. McKeithen's mortality on 56 gunshot cases was 44.6 per cent, and on 13 stab cases 30.7 per cent.

The experience of the Charity Hospital in New Orleans in these injuries seems to have been greater than that of any other institution, and they have appointed, under the direction of Doctor Matas, a special committee for the study of these cases. Miller's report on a personal experience in 46 cases operated upon there with 23 recoveries, and a paper by Loria dealing with "visceral injuries in gunshot wounds of the abdomen" are the latest communications from this institution. Mason, in his last report, analyzed 127 cases, stressing the influence of hæmorrhage on mortality, and has divided his series into a large and small hæmorrhage group regardless of visceral injury, showing a mortality of 87.2 per cent in the large hæmorrhage series, and 36.1 per cent in the small hæmorrhage series. He urges strongly the

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\*Read before the Philadelphia Academy of Surgery, May 4, 1931.

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more routine use of blood transfusion in these cases. Condict has reported a series of 20 cases from the Gouverneur Hospital, with 11 recoveries.

Winslow, in a report of 31 cases of gunshot and stab wounds of the abdomen treated at the University Hospital, Baltimore, resulting in 16 recoveries and 15 deaths, says that in two cases which died, perforations of the intestine were overlooked at operation. We feel that overlooked injury at the time of operation is one of the most important causes of the present high death rate in perforating wounds of the abdomen. Since studying our own series we are more strongly convinced than ever of this fact, and we may add that with this conviction there has also come a good deal of chagrin, and a lesson which we know will be helpful personally and we hope may be of some assistance to others in the treatment of these injuries. The operations in our series were performed by the attending and assistant attending members of the staff, and the former chief resident physicians of the hospital during this period.

TABLE I

	<i>Stab Cases</i>			<i>Gunshot Cases</i>		
	Recoveries	Deaths		Recoveries	Deaths	
		Operative	Non-operative		Operative	Non-operative
Age average	31.7	40.5	33	26.1	32.9	31
Colored	35	7	2	20	24	6
White	27	10	2	41	31	14
Male	56	15	4	53	47	18
Female	6	2	0	8	8	2

<i>Stab Wounds</i>			
Total stab-wound cases	84	{ recoveries	63
		{ deaths	21
Cases operated upon	77	{ recoveries	60
		{ deaths	17
Cases not operated upon	7	{ recoveries	3
		{ deaths	4

The total mortality of the stab-wound cases is 25 per cent, the operative mortality is 22 per cent. A brief analysis of the cases recovering after operation revealed that in 19 instances there was penetration without visceral injury.

### GROUP I

#### *Stab-wound Injuries—Operation—Recovery*

CASE I—Colored man, thirty-two years old. Operation, hours after injury—? Location of wound—Upper right abdomen. Operative findings—Wound of liver, diaphragm and pleura. Operation—Laparotomy, liver pack, secondary rib resection, drainage. Complications—Sub-diaphragmatic abscess. Days in hospital—Sixty-five.

CASE II—Colored man, thirty-one years old. Operation, hours after injury—Three and one-half. Location of wound—Lower right abdomen, anterior. Operative

findings—Intestine protruding, slight hæmorrhage Operation—Exploratory laparotomy, irrigation N S S, drainage Days in hospital—Twenty-one

CASE III—White man, twenty-three years old Operation, hours after injury—? Location of wound—Lower right abdomen, anterior Operative findings—Penetrating wound, slight hæmorrhage Operation—Exploratory laparotomy, no drainage Days in hospital—Eighteen

CASE IV—White man, forty-seven years old Operation, hours after injury—One and one-half Location of wound—Upper left abdomen, anterior Operative findings—Laceration of mesentery, slight hæmorrhage Operation—Laparotomy, ligation, no drainage, irrigation N S S Days in hospital—Twenty

CASE V—White man, sixteen years old Operation, hours after injury—? Location of wound—Lower left abdomen, anterior Operative findings—Four perforations ileum, laceration of mesentery, severe hæmorrhage Operation—Enterorrhaphy, irrigation N S S, drainage Days in hospital—Thirty-two

CASE VI—White man, thirty-one years old Operation, hours after injury—One and one-quarter Location of wound—Upper left abdomen, from back Operative findings—Wound of spleen, diaphragm, pleura, slight hæmorrhage Operation—Laparotomy, drainage Complications—Pulmonary collapse Days in hospital—Twelve

CASE VII—Colored man, fifty years old Operation, hours after injury—Two Location of wound—Upper left abdomen, anterior Operative findings—Two perforations stomach, slight hæmorrhage Operation—Gastrorrhaphy, no drainage Complications—Local peritonitis Days in hospital—Thirty

CASE VIII—Colored man, thirty-six years old Operation, hours after injury—Three Location of wound—Upper mid-abdomen Operative findings—Wound of stomach, evisceration of stomach and omentum, moderate hæmorrhage Operation—Gastrorrhaphy Days in hospital—Thirteen

CASE IX—White man, twenty years old Operation, hours after injury—Four and one-half Location of wound—Upper left abdomen Operative findings—One perforation of small intestine, laceration mesentery Operation—Enterorrhaphy suture, no drainage Days in hospital—Thirteen

CASE X—White man, twenty-two years old Operation, hours after injury—Three Location of wound—Upper left abdomen Operative findings—Wound of stomach, slight hæmorrhage Operation—Gastrorrhaphy, no drainage Days in hospital—Thirty

CASE XI—White woman, thirty-eight years old Operation, hours after injury—? Location of wound—Left lower abdomen Operative findings—Penetrating wound, severe hæmorrhage, external wound Operation—Exploratory laparotomy, no drainage Days in hospital—Eighteen

CASE XII—White man, twenty-one years old Operation, hours after injury—? Location of wound—Upper left abdomen, anterior, multiple Operative findings—Wound of stomach, diaphragm, pleura Operation—Gastrorrhaphy, suture diaphragm, drainage Days in hospital—Twenty

CASE XIII—White man, twenty-two years old Operation, hours after injury—? Location of wound—Lower left abdomen Operative findings—Penetrating wound Operation—Exploratory laparotomy, no drainage Complications—Partial obstruction fifth day Days in hospital—Seventeen

CASE XIV—White man, twenty-two years old Operation, hours after injury—Eighteen Location of wound—Upper left abdomen, anterior Operative findings—Wound of diaphragm Operation—Exploratory laparotomy, suture diaphragm, no drainage Days in hospital—Fifteen

CASE XV—White man, twenty-five years old Operation, hours after injury—One Location of wound—Upper left abdomen, lateral Operative findings—Laceration of

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mesentery, moderate hæmorrhage Operation—E\ploratory laparotomy, suture mesentery, drainage Days in hospital—Eleven

CASE XVI—White man, forty-seven years old Operation, hours after injury—Two Location of wound—Lower abdomen Operative findings—Laceration of mesentery, evisceration of small intestine and omentum, moderate hæmorrhage Operation—Repair mesentery, no drainage Complications—Pneumonia Days in hospital—Twenty-five

CASE XVII—White man, thirty-one years old Operation, hours after injury—Two Location of wound—Lower right abdomen, anterior Operative findings—Omentum protruding, no visceral injury Operation—E\ploratory laparotomy, drainage Complications—Local peritonitis Days in hospital—Thirteen

CASE XVIII—White man, twenty-three years old Operation, hours after injury—? Location of wound—Upper left abdomen, anterior Operative findings—Small puncture liver, slight hæmorrhage Operation—E\ploratory laparotomy, suture liver, drainage Days in hospital—Twenty-three

CASE XIX—Colored man, fifty years old Operation, hours after injury—One and three-quarters Location of wound—Lower left abdomen, anterior Operative findings—Penetrating wound, small intestine protruding Operation—E\ploratory laparotomy, drainage Days in hospital—Twenty

CASE XX—White man, twenty-two years old Operation, hours after injury—Three Location of wound—Upper right abdomen, anterior Operative findings—Four perforations large intestine, severe hæmorrhage Operation—Enterorrhaphy, irrigation N S S, drainage Days in hospital—Twenty-eight

CASE XXI—White man, twenty years old Operation, hours after injury—One Location of wound—Lower left abdomen, lateral Operative findings—Penetrating wound, omentum protruding Operation—E\ploratory laparotomy, drainage Days in hospital—Thirteen

CASE XXII—White man, twenty-six years old Operation, hours after injury—? Location of wound—Abdomen Operative findings—Penetrating wound, slight hæmorrhage Operation—E\ploratory laparotomy, drainage Days in hospital—Fourteen

CASE XXIII—Colored man, twenty-seven years old Operation, hours after injury—One Location of wound—Upper left abdomen, anterior Operative findings—Wound of stomach, laceration of omentum, moderate hæmorrhage Operation—Gastrorrhaphy, repair omentum, drainage Complications—Pulmonary collapse right lower lobe Days in hospital—Nineteen

CASE XXIV—Colored man, twenty-four years old Operation, hours after injury—One and one-half Location of wound—Lower left abdomen, anterior Operative findings—Penetrating wound Operation—E\ploratory laparotomy, no drainage Days in hospital—Nine

CASE XXV—White man, thirty-five years old Operation, hours after injury—? Location of wound—Upper left abdomen, chest Operative findings—Two perforations jejunum, multiple wounds mesentery, puncture left pleura, severe hæmorrhage Operation—Resection of jejunum with end-to-end anastomosis, drainage Days in hospital—Thirty-two

CASE XXVI—Colored man, twenty-four years old Operation, hours after injury—Four Location of wound—Upper left abdomen, anterior Operative findings—Penetrating wound, slight hæmorrhage Operation—E\ploratory laparotomy, no drainage Days in hospital—Twelve

CASE XXVII—White man, twenty-eight years old Operation, hours after injury—One Location of wound—Upper and lower right abdomen Operative findings—Wound of bladder, slight hæmorrhage Operation—Suture bladder, drainage Days in hospital—Sixteen

CASE XXVIII—White man, twenty-five years old Operation, hours after injury—Five and one-half Location of wound—Lower right abdomen, anterior Operative

findings—Penetrating wound, laceration of omentum, omentum protruding, moderate hæmorrhage Operation—Exploratory laparotomy, suture, ligation, no drainage Days in hospital—Fourteen

CASE XXIX—Colored man, forty-two years old Operation, hours after injury—Two and one-half Location of wound—Lower left abdomen, anterior Operative findings—One perforation small intestine, moderate hæmorrhage Operation—Enterorrhaphy, suture, drainage Days in hospital—Seventeen

CASE XXX—White man, twenty-six years old Operation, hours after injury—Two Location of wound—Upper right abdomen, anterior Operative findings—Penetrating wound Operation—Exploratory laparotomy, no drainage Complications—Infection of wound Days in hospital—Twenty

CASE XXXI—Colored man, forty-nine years old Operation, hours after injury—Two and one-half Location of wound—Anterior abdomen Operative findings—Penetrating wound, severe hæmorrhage from omentum Operation—Exploratory laparotomy, ligation, no drainage Days in hospital—Nineteen

CASE XXXII—Colored man, thirty-six years old Operation, hours after injury—One Location of wound—Upper left abdomen, posterior lateral Operative findings—Small intestine protruding through penetrating wound Operation—Exploratory laparotomy no drainage Days in hospital—Nineteen

CASE XXXIII—White man, thirty-five years old Operation, hours after injury—Three-quarters Location of wound—Upper left abdomen, anterior Operative findings—Laceration of mesentery of small intestine Operation—Exploratory laparotomy, suture no drainage Days in hospital—Fourteen

CASE XXXIV—White man, thirty-eight years old Operation, hours after injury—Two Location of wound—Upper left abdomen, anterior Operative findings—Severance of hypogastric vein, wound of mesentery, descending colon Operation—Exploratory laparotomy, ligation Days in hospital—Eighteen

CASE XXXV—White man, thirty-nine years old Operation, hours after injury—One Location of wound—Upper left abdomen, anterior Operative findings—Perforation of jejunum, laceration of mesentery, hæmorrhage Operation—Enterorrhaphy, suture no drainage Days in hospital—Eighteen

CASE XXXVI—Colored man, twenty-six years old Operation, hours after injury—Two Location of wound—Upper left abdomen, anterior Operative findings—Penetrating wound of liver moderate hæmorrhage Operation—Laparotomy, suture of liver no drainage Days in hospital—Fourteen

CASE XXXVII—Colored man, 2 years old Operation, hours after injury—One Location of wound—Lower right abdomen, anterior Operative findings—Penetrating wound Operation—Exploratory laparotomy, no drainage Days in hospital—Sixteen

CASE XXXVIII—Colored woman, fifty years old Operation, hours after injury—Three and one-half Location of wound—Left lateral abdomen (flank) Operative findings—Penetrating wound, laceration mesentery, descending colon Operation—Exploratory laparotomy, ligation, drainage Days in hospital—Thirty

CASE XXXIX—Colored man, eighteen years old Operation, hours after injury—One Location of wound—Lower right abdomen, anterior Operative findings—Omentum protruding Operation—Omentum excised no drainage Days in hospital—Thirteen

CASE XL—Colored man, thirty-five years old Operation, hours after injury—Fourteen Location of wound—Lower left abdomen anterior Operative findings—Penetrating wound, slight hæmorrhage Operation—Exploratory laparotomy, drainage Complications—Local peritonitis Days in hospital—Fourteen

CASE XLI—Colored man thirty-five years old Operation, hours after injury—One Location of wound—Upper left abdomen, anterior Operative findings—Pene-

## PENETRATING WOUNDS OF THE ABDOMEN

trating wound, evisceration jejunum, slight hæmorrhage Operation—E\ploratory laparotomy, ligation, no drainage Days in hospital—Seventeen

CASE XLII—White man, twenty-eight years old Operation, hours after injury—One Location of wound—Upper left abdomen, lateral (flank) Operative findings—Two perforations small intestine, two of large intestine, laceration of mesentery, severe hæmorrhage Operation—Enterorrhaphy, with drainage Days in hospital—Thirty

CASE XLIII—Colored man, twenty-five years old Operation, hours after injury—Nine and one-half Location of wound—Upper left abdomen, anterior Operative findings—One perforation small intestine, laceration of mesentery, severe hæmorrhage Operation—Enterorrhaphy, suture, ligation, no drainage Complications—General peritonitis Days in hospital—Twenty-three

CASE XLIV—White man, forty years old Operation, hours after injury—One and one-half Location of wound—Upper and lower left abdomen, anterior Operative findings—Evisceration of omentum and small intestine Operation—E\ploratory laparotomy, no drainage Days in hospital—Sixteen

CASE XLV—White man, thirty-two years old Operation, hours after injury—Seven Location of wound—Lower left abdomen, anterior Operative findings—Laceration peritoneal, coat of sigmoid, slight hæmorrhage Operation—E\ploratory laparotomy, suture, no drainage Days in hospital—Seventeen

CASE XLVI—Colored man, thirty-four years old Operation, hours after injury—Two Location of wound—Lower left abdomen Operative findings—Penetrating wound, omentum protruding Operation—E\ploratory laparotomy, with drainage Complications—Wound infection Days in hospital—Thirty-four

CASE XLVII—Colored man, thirty-five years old Operation, hours after injury—One and one-quarter Location of wound—Lower left abdomen Operative findings—One perforation small intestine, slight hæmorrhage, evisceration small intestine Operation—Enterorrhaphy, suture, with drainage Days in hospital—Eighteen

CASE XLVIII—Colored woman, twenty-three years old Operation, hours after injury—Eight Location of wound—Upper right abdomen, anterior Operative findings—Laceration of gastrocolic omentum, severe hæmorrhage Operation—E\ploratory laparotomy, drainage Complications—Wound infection Days in hospital—Thirty-three

CASE XLIX—Colored man, thirty-one years old Operation, hours after injury—One Location of wound—Upper left abdomen, anterior Operative findings—Laceration mesentery, transverse colon, moderate hæmorrhage Operation—E\ploratory laparotomy, ligation, drainage Complications—Wound infection Days in hospital—Nineteen

CASE L—Colored man, twenty-five years old Operation, hours after injury—Two Location of wound—Lower right abdomen, anterior Operative findings—One perforation small intestine, omentum protruding, slight hæmorrhage Operation—Enterorrhaphy, suture, drainage Complications—Local peritonitis Days in hospital—Twenty-seven

CASE LI—Colored woman, twenty-two years old Operation, hours after injury—One and one-half Location of wound—Upper right abdomen, anterior Operative findings—Wound of liver, severe hæmorrhage Operation—E\ploratory laparotomy, pack, drainage Days in hospital—Fifteen

CASE LII—Colored man, ? years old Operation, hours after injury—Five Location of wound—Upper left abdomen Operative findings—Laceration of mesentery, moderate hæmorrhage Operation—E\ploratory laparotomy, ligation, drainage Complications—Left pleurisy Days in hospital—Seventeen

CASE LIII—White man, thirty-two years old Operation, hours after injury—Two and one-half Location of wound—Upper left abdomen, anterior Operative findings—Penetrating wound, round ligament of liver severed Operation—E\ploratory laparotomy, no drainage Days in hospital—Fifteen

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CASE LIV—Colored man, thirty-four years old Operation, hours after injury—Two Location of wound—Upper left abdomen, anterior Operative findings—Laceration of gall-bladder, omentum protruding, slight hemorrhage Operation—Exploratory laparotomy, suture ligation with drainage Days in hospital—Eighteen

CASE LV—Colored man, thirty-nine years old Operation, hours after injury—Five Location of wound—Upper left abdomen, lateral Operative findings—Penetrating wound, severe hemorrhage, laceration gastrocolic omentum, omentum protruding Operation—Exploratory laparotomy, ligation with drainage, reinfusion 500 cubic centimetres of blood Complications—Wound infection Days in hospital—Twenty-three

CASE LVI—Colored man, twenty-two years old Operation, hours after injury—One-half Location of wound—Lower left abdomen, anterior Operative findings—One perforation small intestine, slight hemorrhage, omentum protruding Operation—Enterorrhaphy, no drainage Days in hospital—Eleven

CASE LVII—Colored female, twenty-eight years old Operation, hours after injury—Ten Location of wound—Upper left abdomen, from back Operative findings—One perforation large intestine, descending colon Operation—Enterorrhaphy, with drainage Complications—Wound infection Days in hospital—Twenty-three

CASE LVIII—Colored man, twenty-nine years old Operation, hours after injury—Two Location of wound—Upper left abdomen, posterior Operative findings—Laceration of spleen (slight) and diaphragm, slight hemorrhage, omentum protruding Operation—Exploratory laparotomy, suture with drainage Complications—Wound rupture ninth day, resutured Days in hospital—Thirty-one

CASE LIX—Colored man, thirty-eight years old Operation, hours after injury—Four Location of wound—Upper left abdomen, anterior Operative findings—Wound of liver, pancreas (slight), severe hemorrhage Operation—Exploratory laparotomy, packing with drainage Days in hospital—Seventeen

CASE LX—Colored man, twenty-five years old Operation, hours after injury—Twelve Location of wound—Upper left abdomen, anterior Operative findings—One perforation of anterior wall of stomach Operation—Gastrorrhaphy, suture with drainage Complications—Wound infection Days in hospital—Twenty-three

### *Stab-wound Injuries—No Operation—Recovery*

CASE I—White man, thirty-five years old Multiple stab wounds, penetrating, but probably no perforations Refused operation Left hospital in two days with signs of peritonitis still present Readmitted to hospital three times during the next month without abdominal symptoms, but infection still present in shoulder wounds

CASE II—Colored man, thirty-six years old Single stab wound, penetrating but probably no visceral injury Refused operation Apparently had local peritonitis which subsided Left hospital in five days, earlier than advised, but in good condition

CASE III—Colored man, thirty-two years old Multiple stab wounds Penetrating wound right thoracic cavity, surgical emphysema (no effusion of consequence), penetrating wound upper abdomen without visceral injury, no peritonitis, no infection of wounds, no complications Left the hospital in eleven days

### *Stab-wound Injuries—Operation—Death*

CASE I—Colored man, twenty-four years old Operation, hours after injury—One and three-quarters Location of wound injury—Lower right abdomen, anterior Operative findings—Two perforations small intestine, two of large intestine, severe hemorrhage Operation—Enterorrhaphy, irrigation N S S, drainage Time and autopsy cause of death—Fourteen hours, hemorrhage, shock, early peritonitis

CASE II—Colored woman, fifty-seven years old Operation, hours after injury—Two Location of wound injury—Upper left abdomen Operative findings—Wound

## PENETRATING WOUNDS OF THE ABDOMEN

on under surface of liver, severe hæmorrhage Operation—Exploratory laparotomy, packing Time and autopsy cause of death—On table, hæmorrhage, shock

CASE III—White man, thirty-six years old Operation, hours after injury—Twenty-one Location of wound injury—Upper left abdomen, anterior Operative findings—One perforation of stomach, wound of diaphragm, moderate hæmorrhage Operation—Gastrorrhaphy, suture diaphragm Complications—Delirium tremens Time and autopsy cause of death—Four days, peritonitis, pneumonia, pleurisy, pericarditis

CASE IV—Colored man, twenty-one years old Operation, hours after injury—Three Location of wound injury—Lower left abdomen Operative findings—Wound of mesentery, severe hæmorrhage Operation—Repair mesentery, suture pack, drainage Complications—General peritonitis, lobar-broncho pneumonia Time and autopsy cause of death—Four days, general peritonitis, lobar and broncho pneumonia

CASE V—White man, thirty-nine years old Operation, hours after injury—? Location of wound injury—Left mid-abdomen Operative findings—Six perforations descending colon, severe hæmorrhage Operation—Enterorrhaphy, drainage Complications—Wound infection Time and autopsy cause of death—Four days, peritonitis, pneumonia, leakage from site of repair

CASE VI—Colored man, twenty-nine years old Operation, hours after injury—Two and one-half Location of wound injury—Left lower abdomen, anterior, left chest, anterior Operative findings—No evidence of visceral injury or bleeding found first operation, vomiting seventh day tenth day second operation, obstruction, intestinal leakage at site of obstruction, four days later third operation, intestinal obstruction, leakage faces from wound, condition improved very much for six days, then gradually got worse, died fourteen days after third operation Operation—Exploratory laparotomy, no drainage, second operation, resection, end-to-end anastomosis, drainage, third operation, drainage Complications—Abdominal infection, obstruction, general peritonitis, fæcal fistula Time and autopsy cause of death—Twenty-eight days, general peritonitis and intestinal obstruction, left subphrenic abscess

CASE VII—White man, forty-seven years old Operation, hours after injury—One and three-quarters Location of wound injury—Upper right abdomen, anterior Operative findings—Wound of liver, moderate hæmorrhage Operation—Exploratory laparotomy, suture with drainage Complications—Meningitis Time and autopsy cause of death—Twenty-three days, peritonitis, subphrenic abscess, septic nephritis

CASE VIII—White man, seventy years old Operation, hours after injury—One Location of wound injury—Lower right abdomen, anterior Operative findings—Suicide, excision section small intestine, completely severed colon, severe hæmorrhage Operation—Fixation of severed ends of intestines to abdominal wall Time and autopsy—Three and one-half days, shock and peritonitis, no autopsy

CASE IX—White man, fifty years old Operation, hours after injury—Two Location of wound injury—Left abdomen, upper lateral Operative findings—Wound of spleen and stomach, profuse hæmorrhage, diaphragm injured Operation—Splenic pedicle clamped, packing Time and autopsy cause of death—On table, severe hæmorrhage before operation was concluded

CASE X—White man, twenty-nine years old Operation, hours after injury—Eight (refused early operation) Location of wound injury—Upper left abdomen, anterior Operative findings—Injury to posterior wall of stomach, diaphragm, pleura, moderate hæmorrhage Operation—Gastrorrhaphy suture with drainage Complications—Collapse of left lung, early peritonitis, pleurisy Time and autopsy cause of death—Fifteen hours, hæmorrhage, shock

CASE XI—Colored man, ? years old Operation, hours after injury—One Location of wound injury—Upper right abdomen, anterior Operative findings—Wound through edge of liver, severe hæmorrhage, laceration gastrohepatic omentum Operation—Exploratory laparotomy, three large packs with drainage Time and autopsy



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cause of death—Four hours, hæmorrhage, penetration right pleura, wound superior vena cava overlooked at operation

CASE XII—Colored man, thirty-five years old Operation, hours after injury—One and one-half Location of wound injury—Upper left abdomen, anterior Operative findings—Wound of stomach, severe hæmorrhage, second operation for rupture of wound with evisceration of intestines Operation—First operation, gastrorrhaphy, no drainage, second operation second day, wound repair, drainage Complications—Ruptured wound, general peritonitis Time and autopsy cause of death—Four days, general peritonitis

CASE XIII—White man, twenty-six years old Operation, hours after injury—One to two Location of wound injury—Left abdomen, anterior Operative findings—One perforation small intestine, injury to mesenteric border of ileum, severe hæmorrhage Operation—Enterorrhaphy, no drainage, second day after operation drained for peritonitis Complications—General peritonitis Time and autopsy cause of death—Two days, general peritonitis, fulminating

CASE XIV—White man, forty-four years old Operation, hours after injury—One and one-half Location of wound injury—Right abdomen, multiple of chest and body (17 wounds) Operative findings—One perforation of stomach, transverse colon, laceration of omentum, moderate hæmorrhage, wound of left lung Operation—Gastrorrhaphy, enterorrhaphy, repair omentum, drainage Complications—Delirium tremens Time and autopsy cause of death—Seven days, peritonitis, wounds of liver and left kidney overlooked

CASE XV—Colored man, sixty years old Operation, hours after injury—One Location of wound injury—Upper and lower right abdomen, anterior (multiple) Operative findings—Laceration of liver, penetrating wounds, moderate hæmorrhage Operation—Laparotomy, packing liver wound (too tight) Complications—Pulmonary œdema, biliary fistula Time and autopsy cause of death—Seven days, pneumonia infection of liver wound, subphrenic abscess

CASE XVI—Colored woman, twenty-five years old Operation, hours after injury—Four and one-half Location of wound injury—Upper left abdomen, anterior Operative findings—Six perforations jejunum, one of transverse colon, moderate hæmorrhage Operation—Enterorrhaphy, ligation, suture, drainage Complications—Local peritonitis, pulmonary œdema Time and autopsy cause of death—Four days, hæmorrhage, shock, advanced pulmonary tuberculosis contributing cause

CASE XVII—White man fifty-three years old Operation, hours after injury—Eighteen Location of wound injury—Lower left abdomen, anterior, multiple Operative findings—Multiple perforations small intestine and mesentery, one of mesosigmoid, moderate hæmorrhage Operation—Resection of fifteen inches ileum and lateral anastomosis, drainage Time and autopsy cause of death—Four days, septic peritonitis

### *Stab-wound Injuries—No operation—Death*

CASE I—White man, forty years old Multiple stab wounds of heart and abdomen, penetrating Died two minutes after admission No autopsy

CASE II—White man, forty-two years old Single stab wound left upper abdomen Had generalized œdema with cardiac decompensation Suicide Died in twenty hours No autopsy

CASE III—Colored man, ? years old Single stab wound left upper abdomen Died immediately after admission Autopsy showed clot in pericardium causing compression of heart, right side of right ventricle penetrated

CASE IV—Colored man, twenty-three years old Single stab wound epigastrium Signs of severe hæmorrhage, omentum protruding Died in twenty minutes No autopsy

## PENETRATING WOUNDS OF THE ABDOMEN

The mesentery was injured in 17 cases (no associated injuries in 7)  
 The omentum was injured in 6 cases (no associated injuries in 2)  
 The stomach was injured in 6 cases (multiple—1)  
 The small intestine was injured in 11 cases (multiple—3)  
 The large intestine was injured in 3 cases (multiple—2)  
 The urinary bladder was injured in 1 case  
 The liver was injured in 3 cases  
 The spleen was injured in 1 case (small wound)  
 The pancreas was injured in 1 case (small wound)

Evisceration was noted in 17 instances	{	intestine	8
		stomach	1
		omentum	8

In 7 cases the pleural cavity was penetrated	{	unilateral	6
		bilateral	1

The diaphragm was perforated in 5 cases

Hæmorrhage was severe in 7 cases, moderate in 11, and slight in 16. In 26 there was no note as to hæmorrhage. Shock as a rule was not marked except when associated with considerable hæmorrhage. It was surprisingly slight in most of the evisceration cases. In several instances the patients had walked into the receiving ward with a part of their intestines resting in their clothes with but little evidence of shock. The operative procedure in this group was very simple.

A resection with end-to-end anastomosis was done in one case for multiple injuries to the jejunum and its mesentery. In 20 cases the wound was closed without drainage, including 14 without visceral injury, 3 stomach perforations, 2 small intestine perforations, and one liver wound. The complications included—wound infection, 7, rupture of wound and evisceration (ninth day), 1, partial obstruction, 1, pneumonia, 2, pulmonary collapse, 2, pleurisy, 1, subphrenic abscess, 1, and phlebitis, 1.

Three cases recovered without operation who suffered penetrating wounds. Two of these patients refused to have operations performed. The other one was admitted many hours after being stabbed without symptoms of visceral injury, and was treated conservatively. We do not believe that any of them suffered visceral damage.

Seventeen of the 77 cases operated upon died. Autopsies were performed on 15 cases (88 per cent). There are a few outstanding features in this group. In 9 cases hæmorrhage was severe, and in 7 it was moderate in amount. Four deaths occurred within fifteen hours, and can be attributed directly to hæmorrhage and shock. Thirteen died within four days, and all severe hæmorrhage cases died within four days. In 2 cases resection of small intestine was done (one lateral and one end-to-end anastomosis). In four cases the abdomen was closed without drainage. At autopsy peritonitis was found in 11 cases, pneumonia in 3, and subphrenic abscess in three. Wounds of the liver and left kidney were overlooked at operation in a case suffering multiple penetrating wounds of chest and abdomen with perforations of stomach and colon. The cause of death was peritonitis on the

## BILLINGS AND WALKLING

seventh day In one case leakage occurred after repair of six perforations of the colon Death resulted on the fourth day from peritonitis

		<i>Gunshot Wounds</i>	
Total gunshot-wound cases	136	{ recoveries	61
		{ deaths	75
Cases operated upon	114	{ recoveries	59
		{ deaths	55
Cases not operated upon	22	{ recoveries	2
		{ deaths	20

A total mortality of 55 14 per cent is shown in this group and an operative mortality of 48 2 per cent In the group of operative recoveries of which there were 59, hæmorrhage was severe in 27, moderate in 12, slight in 12, and no note as to hæmorrhage in 8 cases In 21 cases visceral injuries were single, and in 32 they were multiple

### GROUP II

#### *Gunshot Wound Injuries—Operation—Recovery*

CASE I—Colored man, forty-two years old Operation, hours after injury—Two Location of wound—Upper left abdomen anterior Operative findings—Wound of liver, severe hæmorrhage Operation—Packing wound, drainage Days in hospital—Thirty-four

CASE II—Colored man, twenty-seven years old Operation, hours after injury—One and one-quarter Location of wound—Lower left abdomen, anterior Operative findings—Two perforations sigmoid, moderate hæmorrhage Operation—Enterorrhaphy, suture, drainage Complications—Wound infection Days in hospital—Eighteen

CASE III—Colored man twenty-seven years old Operation, hours after injury—Three Location of wound—Lower left abdomen anterior Operative findings—Wound of bladder, slight hæmorrhage Operation—Marsupialization with drainage Days in hospital—Fifty-nine

CASE IV—White man, seventy-three years old Operation, hours after injury—One and one-half Location of wound—Upper left abdomen, anterior Operative findings—Perforation of stomach severe hæmorrhage Operation—Gastrorrhaphy, suture, drainage Days in hospital—Fifty-nine

CASE V—White man, nineteen years old Operation, hours after injury—One and one half Location of wound—Mid-abdomen Operative findings—Two perforations jejunum severe hæmorrhage Operation—Enterorrhaphy, suture, packing Complications—Pneumonia effusion Days in hospital—Forty

CASE VI—White woman, sixteen years old Operation hours after injury—? Location of wound—Right upper abdomen Operative findings—Wound of liver severe hæmorrhage Operation—Packing wound Days in hospital—Fourteen

CASE VII—Colored man, twenty-six years old Operation, hours after injury—Three and one-half Location of wound—Lower left abdomen, posterior Operative findings—Wound right ureter Operation—Drainage Complications—Urinary fistula, posterior healed spontaneously Days in hospital—Forty-four

CASE VIII—Colored woman twenty-five years old Operation hours after injury—Two Location of wound—Lower left abdomen, anterior Operative findings—Wound of liver, severe hæmorrhage Operation—Packing wound drainage Complications—Liver abscess? drainage, fever five weeks Days in hospital—Seventy

## PENETRATING WOUNDS OF THE ABDOMEN

CASE IX—White man, twenty-one years old Operation, hours after injury—Two Location of wound—Upper left abdomen, anterior Operative findings—Wound of liver, moderate hæmorrhage Operation—Packing wound Complications—Pleurisy, pneumonia Days in hospital—Nineteen

CASE X—White woman, twenty-three years old Operation, hours after injury—One and one-half Location of wound—Upper right abdomen, anterior Operative findings—Wound of pancreas, one perforation of small intestine and one of stomach, moderate hæmorrhage Operation—Gastrorrhaphy, enterorrhaphy, suture, drainage Complications—Duodenal fistula, local peritonitis, fistula healed spontaneously Days in hospital—Ninety-two

CASE XI—White man, twenty-seven years old Operation, hours after injury—One Location of wound—Upper right abdomen, anterior Operative findings—Two perforations stomach, six perforations small intestine, one of transverse colon and one of rectum, moderate hæmorrhage Operation—Gastrorrhaphy, enterorrhaphy, irrigation with N S S, drainage Days in hospital—Twenty-five

CASE XII—White man, twenty-five years old Operation, hours after injury—Five Location of wound—Upper left abdomen, anterior Operative findings—Wound of diaphragm, pleura Operation—Laparotomy, no drainage Days in hospital—Twelve

CASE XIII—White man, twenty-two years old Operation, hours after injury—One to one and one-half Location of wound—Upper left abdomen, posterior Operative findings—Wound of liver and stomach, moderate hæmorrhage Operation—Gastrorrhaphy, drainage Days in hospital—Thirty

CASE XIV—White man, thirty-three years old Operation, hours after injury—? Location of wound—Upper left abdomen, posterior Operative findings—Penetrating wound Operation—Laparotomy, no drainage Days in hospital—Nineteen

CASE XV—White girl, twelve years old Operation, hours after injury—? Location of wound—Lower abdomen Operative findings—Two perforations small intestine, slight hæmorrhage Operation—Enterorrhaphy, drainage Days in hospital—Fifteen

CASE XVI—White man, forty-three years old Operation, hours after injury—Twenty-seven Location of wound—Upper right abdomen, two wounds Operative findings—One perforation of cæcum, moderate hæmorrhage Operation—Enterorrhaphy, drainage Days in hospital—Twenty-three

CASE XVII—Colored man, twenty-eight years old Operation, hours after injury—? Location of wound—Left upper abdomen Operative findings—Perforation of spleen, severe hæmorrhage Operation—Splenectomy, gauze pack, drainage, transfusion Complications—On twenty-fifth day onset of severe tertian malarial infection, plasmodia recovered, responded to quinine therapy Days in hospital—Forty-five

CASE XVIII—Colored man, forty years old Operation, hours after injury—Two to three Location of wound—Left upper abdomen Operative findings—No visceral injury, penetrating wound Operation—Exploratory laparotomy, no visceral injury Complications—Hemothorax, thorocotomy, drainage Days in hospital—Sixteen

CASE XIX—White boy, five years old Operation, hours after injury—? Location of wound—Upper right abdomen, anterior Operative findings—Wound of liver, severe hæmorrhage Operation—Packing wound, drainage Complications—Biliary fistula, subphrenic abscess Days in hospital—Thirty-nine

CASE XX—Colored man, thirty-four years old Operation, hours after injury—One and one-half Location of wound—Upper left abdomen, posterior Operative findings—Wound left kidney, severe hæmorrhage Operation—Nephrectomy, drainage Complications—Wound infection Days in hospital—Twenty-five

CASE XXI—White man, thirty-five years old Operation, hours after injury—One Location of wound—Upper right abdomen, lateral Operative findings—Wound of liver, anterior surface, severe hæmorrhage Operation—Packing of wound with vaseline gauze Days in hospital—One hundred and two

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CASE XXII—White man, twenty-three years old Operation, hours after injury—Two and three-quarters Location of wound—Lower abdomen, anterior Operative findings—Injury to veins in pelvis, severe hæmorrhage Operation—Packing in pelvis, drainage Days in hospital—Seventeen

CASE XXIII—White man, eighteen years old Operation, hours after injury—Twenty-six Location of wound—Upper right abdomen Operative findings—Two perforations small intestine, severe hæmorrhage, laceration mesentery Operation—Enterorrhaphy, drainage, suture Complications—Influenza Days in hospital—Thirty-one

CASE XXIV—Colored man, thirty years old Operation, hours after injury—Two Location of wound—Lower left abdomen, anterior Operative findings—Large hæmatoma in spermatic cord, moderate hæmorrhage Operation—Drainage Days in hospital—Fourteen

CASE XXV—White man, thirty-eight years old Operation, hours after injury—One Location of wound—Lower abdomen Operative findings—Thirteen perforations small intestine, one of bladder, moderate hæmorrhage Operation—Enterorrhaphy, lateral anastomosis without resection, suture, drainage Days in hospital—Forty-four

CASE XXVI—Colored man, twenty-five years old Operation, hours after injury—One and one-half Location of wound—Upper right abdomen, lateral Operative findings—Wound of liver and diaphragm, severe hæmorrhage Operation—Packing liver wound, drainage Complications—Wound infection Days in hospital—Twenty-three

CASE XXVII—White man, nineteen years old Operation, hours after injury—Two Location of wound—Lower abdomen from back Operative findings—Laceration gastro-colic omentum, injury lumbar plexus, severe hæmorrhage Operation—Suture, no drainage Complications—Paralysis left foot, wound infection, general peritonitis Days in hospital—Forty-three

CASE XXVIII—White man, thirty-four years old Operation, hours after injury—One and three-quarters Location of wound—Upper right abdomen from back Operative findings—Wound right lobe liver, right kidney, severe hæmorrhage Operation—Packing, drainage, suture Days in hospital—Twenty

CASE XXIX—White man, twenty-two years old Operation, hours after injury—Two Location of wound—Upper right, left abdomen, anterior Operative findings—Wound of liver and stomach, severe hæmorrhage Operation—Gastrorrhaphy, packing Days in hospital—Twenty-five

CASE XXX—Colored man, forty-one years old Operation, hours after injury—? Location of wound—Lower left abdomen, anterior Operative findings—Four perforations small intestine, thrombosis of veins, mesentery Operation—Resection with lateral anastomosis, wound resutured sixth day, drainage Complications—General peritonitis Days in hospital—Thirty-four

CASE XXXI—White girl, twelve years old Operation, hours after injury—One Location of wound—Upper abdomen Operative findings—Wound of liver, spleen, stomach Operation—Suture, gauze pack, gastrorrhaphy, drainage Days in hospital—Twenty-six

CASE XXXII—White man, twenty-seven years old Operation hours after injury—One and one-half Location of wound—Upper abdomen, posterior, left side Operative findings—Upper edge of spleen nicked, slight hæmorrhage Operation—Packing vaseline gauze, drainage Complications—Pleurisy Days in hospital—Thirteen

CASE XXXIII—White man, thirty-two years old Operation, hours after injury—One Location of wound—Lower left abdomen, anterior Operative findings—Six perforations small intestine, one of sigmoid, several perforations omentum, severe hæmorrhage Operation—Enterorrhaphy, ligation, resection ileum, end-to-end anastomosis no drainage Complications—General peritonitis, wound infections Days in hospital—Twenty-eight

CASE XXXIV—White man, eighteen years old Operation, hours after injury—?

## PENETRATING WOUNDS OF THE ABDOMEN

Location of wound—Upper left abdomen, posterior Operative findings—One perforation of stomach, four of jejunum, slight hæmorrhage Operation—Gastrorrhaphy, enterorrhaphy, suture ligation, drainage Complications—Wound infection Days in hospital—Twenty-six

CASE XXXV—White man, forty years old Operation, hours after injury—? Location of wound—Upper right abdomen, anterior Operative findings—Wound of liver, diaphragm, pleura, severe hæmorrhage Operation—Pack liver wound, drainage Complications—Subphrenic abscess, hæmorrhage Days in hospital—Sixty-six

CASE XXXVI—White man, thirty-eight years old Operation, hours after injury—One Location of wound—Upper right abdomen, anterior Operative findings—Wound of liver, diaphragm, pleura, moderate hæmorrhage Operation—Packing, drainage Complications—Pneumothorax Days in hospital—Eighteen

CASE XXXVII—Colored man, twenty-seven years old Operation, hours after injury—Three and one-half Location of wound—Upper left abdomen, lateral, flank Operative findings—Three perforations sigmoid, three of mesentery, moderate hæmorrhage Operation—Suture, enterorrhaphy, drainage Complications—Slight local peritonitis Days in hospital—Twenty-eight

CASE XXXVIII—White man, forty-one years old Operation, hours after injury—Five Location of wound—Lower left abdomen, anterior Operative findings—Nine perforations small intestine, severe hæmorrhage, laceration mesentery Operation—Enterorrhaphy, drainage, suture, ligation Complications—Wound infections Days in hospital—Twenty-four

CASE XXXIX—White man, forty-four years old Operation, hours after injury—One Location of wound—Upper right abdomen, anterior Operative findings—Penetrating wound of abdomen, slight hæmorrhage Operation—Exploratory laparotomy, no drainage Complications—Fracture right ileum Days in hospital—Seventeen

CASE XL—White man, twenty-six years old Operation, hours after injury—One Location of wound—Upper right abdomen, anterior Operative findings—Wound of liver, severe hæmorrhage Operation—Packing, drainage Complications—Wound infection, bronchopneumonia Days in hospital—Forty-five

CASE XLI—White boy, fifteen years old Operation, hours after injury—One Location of wound—Lower left abdomen, anterior Operative findings—Eight perforations of ileum Operation—Resection ileum, end-to-end anastomosis, no drainage Complications—Wound infection Days in hospital—Twenty-five

CASE XLII—White man, twenty-eight years old Operation, hours after injury—One and one-half Location of wound—Upper right abdomen, anterior Operative findings—Wound of liver, slight hæmorrhage Operation—Packing liver wound, drainage Days in hospital—Sixteen

CASE XLIII—White boy, fourteen years old Operation, hours after injury—? Location of wound—Upper right abdomen, anterior Operative findings—Perforation of small intestine, laceration mesentery, ascending colon, retroperitoneal hematoma, slight hæmorrhage Operation—Enterorrhaphy, suture, drainage Days in hospital—Eighteen

CASE XLIV—Colored man, forty-one years old Operation, hours after injury—One Location of wound—Upper right abdomen, lateral Operative findings—Wound of liver, slight hæmorrhage Operation—Packing liver wound, drainage Complications—Fracture eleventh and twelfth ribs Days in hospital—Twenty-two

CASE XLV—Colored man, twenty-five years old Operation, hours after injury—Thirty-six Location of wound—Upper right buttock Operative findings—Wound of bladder Operation—Exploratory laparotomy, drainage second operation thirty days later, bullet removed from bladder through suprapubic wound after localization by cystoscope Days in hospital—Forty-three

CASE XLVI—Colored man, twenty-four years old Operation, hours after injury—Two Location of wound—Upper right abdomen, lateral Operative findings—Large

jagged wound of liver, severe hemorrhage Operation—Packing wound, drainage  
Complications—Wound infection, drained bile Days in hospital—Thirty

CASE XLVII—White man, twenty-seven years old Operation, hours after injury—? Location of wound—Upper right and left abdomen Operative findings—Wound of left kidney, retroperitoneal hematoma, moderate hemorrhage Operation—Exploratory laparotomy, suture of kidney Days in hospital—Twenty-four

CASE XLVIII—Colored man, thirty-one years old Operation, hours after injury—One and one-quarter Location of wound—Upper right abdomen, anterior Operative findings—Wound of liver, moderate hemorrhage Operation—Packing, drainage, reinfusion or replacement of 300 cubic centimetres blood Complications—Pneumonia Days in hospital—Forty

CASE XLIX—White man, twenty-nine years old Operation, hours after injury—One Location of wound—Right lateral abdomen, flank Operative findings—Nine perforations ileum and jejunum, injury to mesentery of ascending colon severe hemorrhage Operation—Enterorrhaphy, suture, drainage Complications—Fracture head of left humerus Days in hospital—Twenty-five

CASE L—Colored woman, thirty years old Operation, hours after injury—Ten (refused early operation) Location of wound—Lower right abdomen, anterior Operative findings—No visceral injury, slight hemorrhage Operation—Exploratory laparotomy, X-ray disclosed bullet lodged in uterus Days in hospital—Twenty-three

CASE LI—Colored man, twenty-two years old Operation, hours after injury—? Location of wound—Upper right abdomen Operative findings—Ten perforations of small intestine, severe hemorrhage, injury to mesentery Operation—Enterorrhaphy Days in hospital—Twenty-six

CASE LII—White man, nineteen years old Operation, hours after injury—One Location of wound—Upper right abdomen, lateral Operative findings—Wound of liver, two perforations of stomach, injury to mesentery, moderate hemorrhage Operation—Gastrorrhaphy, suture, packing liver wound, drainage Complications—Wound infection Days in hospital—Thirty-two

CASE LIII—White man, twenty-five years old Operation, hours after injury—Fourteen and one-half Location of wound—Upper right abdomen, anterior Operative findings—Wound of liver and diaphragm, severe hemorrhage Operation—Packing liver wound drainage, laparotomy Days in hospital—Twenty-two

CASE LIV—Colored woman, twenty-four years old Operation, hours after injury—Twenty-one Location of wound—Lower abdomen anterior Operative findings—Wound of bladder Operation—Exploratory laparotomy, suture, drainage Days in hospital—Forty-three

CASE LV—Colored man, twenty-three years old Operation, hours after injury—One and one-half Location of wound—Upper left abdomen anterior Operative findings—Nine perforations of small intestine, ileum, slight hemorrhage Operation—Enterorrhaphy drainage Days in hospital—Fourteen

CASE LVI—White boy, thirteen years old Operation, hours after injury—One and one-quarter Location of wound—Upper left abdomen, anterior Operative findings—Wound of liver contusions small intestines, two perforations transverse colon slight hemorrhage Operation—Enterorrhaphy, drainage, suture Days in hospital—Thirty

CASE LVII—White boy, eight years old Operation, hours after injury—One and one-quarter Location of wound—Upper abdomen, anterior Operative findings—Wound of liver, pancreas, two perforations of stomach, severe hemorrhage Operation—Gastrorrhaphy, pack liver wound drainage Days in hospital—Forty-four

CASE LVIII—White woman, twenty-six years old Operation hours after injury—Four and three-quarters Location of wound—Lower abdomen, posterior Operative findings—Two perforations small intestine, two of large intestine, slight hemorrhage,

## PENETRATING WOUNDS OF THE ABDOMEN

laceration left ovary Operation—Enterorrhaphy, suture, drainage Days in hospital—Twenty-seven

CASE LIX—White man, thirty years old Operation, hours after injury—One and one-half Location of wound—Upper left abdomen, anterior Operative findings—Ten perforations small intestine, two of large intestine, severe hæmorrhage Operation—Enterorrhaphy, drainage, suture, transfusion Days in hospital—Twenty-five

### *Gunshot Wound Injuries—No Operation—Recovery*

CASE I—White man, thirty-eight years old Multiple bullet wounds Admitted with signs of hæmorrhage, conservative treatment instituted, condition steadily improved Probably wound of spleen with no other visceral injuries Recovery, thirty-eight days

CASE II—White man, thirty-one years old Single wound upper abdomen No signs of perforation on admission, vomited blood on third day, condition had improved so much that conservative treatment was continued Probably wound of stomach

### *Gunshot-wound Injuries—Operation—Death*

CASE I—White man, twenty-eight years old Operation, hours after injury—One and one-quarter Location of wound—Upper right abdomen, anterior Operative findings—Wound of liver, diaphragm and pleura, severe hæmorrhage Operation—Exploratory laparotomy, packing, drainage, irrigation N S S Time and autopsy cause of death—Twenty-seven hours, hemothorax, hæmorrhage, early peritonitis

CASE II—White man, forty-three years old Operation, hours after injury—Twelve Location of wound—Upper left abdomen, anterior Operative findings—Wound of liver, two perforations of stomach, three of small intestine, severe hæmorrhage Operation—Gastrorrhaphy, enterorrhaphy, suture, packing, irrigation N S S, drainage Time and cause of death—Forty-six days, subphrenic abscess, no autopsy

CASE III—White boy, four years old Operation, hours after injury—One and one-quarter Location of wound—Lower right abdomen, anterior Operative findings—Eleven perforations of small intestine, moderate hæmorrhage Operation—Enterorrhaphy, irrigation N S S, drainage Time and autopsy cause of death—Thirty-six hours, early peritonitis, acute dilatation of heart

CASE IV—White man, twenty-six years old Operation, hours after injury—One Location of wound—Upper right abdomen, lateral Operative findings—Wound of liver and duodenum, injury to transverse mesocolon, moderate hæmorrhage Operation—Enterorrhaphy, suture, drainage Complication—General peritonitis Time and autopsy cause of death—Thirteen days, right subphrenic abscess, peritonitis, duodenal repairs not holding, gangrene and sloughing of retroperitoneal structures, gas-bacillus infection?

CASE V—White man, twenty-one years old Operation, hours after injury—Eighteen Location of wound—Upper right abdomen, lateral Operative findings—Wound of liver, two perforations of stomach, severe hæmorrhage, injury to diaphragm Operation—Gastrorrhaphy, drainage Time and autopsy cause of death—Two hours after operation, hæmorrhage and shock

CASE VI—White man, thirty years old Operation, hours after injury—One and one-half Location of wound—Upper right abdomen, anterior Operative findings—Wound of liver, diaphragm and pleura, abdomen filled with blood, severe hæmorrhage Operation—Exploratory laparotomy, packing, drainage Time and autopsy cause of death—Nine hours, hæmorrhage and shock, no autopsy

CASE VII—Colored woman, twenty-four years old Operation, hours after injury—Two Location of wound—Upper left abdomen, lateral Operative findings—Two perforations of diaphragm, pleura, lungs, bleeding at root of mesentery into lesser peritoneal cavity Operation—Exploratory laparotomy, packing, drainage Complica-



## BILLINGS AND WALKLING

tion—Local peritonitis Time and autopsy cause of death—Twenty-four days, subphrenic abscess, perforation of posterior wall of stomach and liver overlooked, sepsis

CASE VIII—Colored man, twenty-four years old Operation, hours after injury—Two Location of wound—Upper left abdomen, lateral Operative findings—Two perforations of stomach, two of small intestine, two of ascending colon, severe hæmorrhage Operation—Gastrorrhaphy, enterorrhaphy, suture, ligation, drainage Time and autopsy cause of death—Twelve hours, hæmorrhage and shock

CASE IX—White woman, forty years old Operation, hours after injury—One and three-quarters Location of wound—Lower right abdomen, lateral Operative findings—Wound of liver, moderate hæmorrhage Operation—Exploratory laparotomy, suture Complication—Early peritonitis Time and autopsy cause of death—Two and one-half days hæmorrhage, peritonitis chronic nephritis

CASE X—Colored man, thirty-two years old Operation, hours after injury—Two Location of wound—Upper right abdomen, anterior Operative findings—Thirteen perforations small intestine two of large intestine, lacerations mesentery, moderate hæmorrhage Operation—Enterorrhaphy, suture, drainage, irrigation N S S Time and autopsy cause of death—Two and one-half days, hæmorrhage, peritonitis, chronic alcoholic nephritis

CASE XI—White man, thirty-two years old Operation, hours after injury—Two Location of wound—Upper right abdomen, lateral Operative findings—Perforating wound of liver, severe hæmorrhage, cavity filled with blood Operation—Exploratory laparotomy, packing, drainage Time and autopsy cause of death—Forty hours, profuse hæmorrhage shock, early peritonitis One perforation stomach, one of spleen, two of diaphragm overlooked

CASE XII—White man, thirty-five years old Operation, hours after injury—Two Location of wound—Upper right abdomen, anterior Operative findings—Eleven perforations of small intestine, severe hæmorrhage Operation—Enterorrhaphy, drainage Time and autopsy cause of death—Twenty-three hours, rapid peritonitis, hæmorrhage

CASE XIII—White man, fifty years old Operation, hours after injury—Three-quarters Location of wound—Upper right abdomen, anterior Operative findings—Wound of liver, two perforations stomach through pylorus, laceration of mesentery, wound of pancreas, severe hæmorrhage Operation—Gastrorrhaphy, packing, drainage Time and autopsy cause of death—Nine hours, hæmorrhage, shock

CASE XIV—Colored man, forty-five years old Operation, hours after injury—One Location of wound—Upper left abdomen, anterior Operative findings—Wound of liver and diaphragm, severe hæmorrhage, probable injury to spinal cord Operation—Exploratory laparotomy, packing, drainage Complications—Retention of urine, incontinence of feces, anesthesia and paralysis both legs to knee Time and autopsy cause of death—Sixteen days, peritonitis, urinary-tract sepsis, injury to pancreas overlooked

CASE XV—White woman, twenty-nine years old Operation, hours after injury—? Location of wound—Upper abdomen Operative findings—Eleven perforations to small intestine, injury to mesentery, severe hæmorrhage Operation—Enterorrhaphy, drainage Time and autopsy cause of death—Fourteen hours, hæmorrhage, shock

CASE XVI—White man, twenty-two years old Operation, hours after injury—One and one-half Location of wound—Anterior abdomen through umbilicus Operative findings—Two perforations small intestine, moderate hæmorrhage Operation—Enterorrhaphy, suture, drainage Time and autopsy cause of death—Thirty-two hours, hæmorrhage, rapid peritonitis

CASE XVII—Colored man, twenty-one years old Operation, hours after injury—Two Location of wound—Lower left abdomen, anterior Operative findings—Six perforations small intestine, laceration of mesentery, severe hæmorrhage Operation—Enterorrhaphy, suture, drainage Time and autopsy cause of death—Five days, general peritonitis retroperitoneal hæmorrhage

CASE XVIII—White man, twenty-four years old Operation, hours after injury—?

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Location of wound—Anterior abdomen Operative findings—Six perforations small intestine, one of mesentery, severe hæmorrhage Operation—Enterorrhaphy, suture, drainage, irrigation N S S Complication—General peritonitis Time and autopsy cause of death—Eight days, general peritonitis, secondary pericarditis

CASE XIX—White man, thirty-two years old Operation, hours after injury—Two Location of wound—Lower right abdomen, lateral Operative findings—Five perforations small intestine, two of cæcum, hematoma root of mesentery, laceration right external iliac vessels, severe hæmorrhage Operation—Enterorrhaphy, suture, drainage with vaseline gauze Time and autopsy cause of death—Two hours after operation, hæmorrhage, shock

CASE XX—Colored man, thirty-eight years old Operation, hours after injury—One and one-half to two Location of wound—Lower left abdomen, anterior Operative findings—Seven perforations small intestine, injury of mesentery, severe hæmorrhage, perforation external iliac vein Operation—Enterorrhaphy, resection and lateral anastomosis, suture, ligation, drainage Time and autopsy cause of death—Four hours, hæmorrhage, shock

CASE XXI—Woman, twenty-four years old Operation, hours after injury—? Location of wound—Upper left abdomen, anterior, right chest, posterior Operative findings—Two perforations jejunum, one of transverse colon, one of ascending colon, wound of diaphragm, right lung, moderate hæmorrhage Operation—Enterorrhaphy, suture, drainage with vaseline gauze Complications—General peritonitis, purulent drainage from wound Time and autopsy cause of death—Forty-eight hours, hæmorrhage, peritonitis, pneumothorax, leakage colon sutures

CASE XXII—White woman, nineteen years old Operation, hours after injury—One and one-half Location of wound—Upper right abdomen, anterior Operative findings—Wound of liver and diaphragm, severe hæmorrhage Operation—Exploratory laparotomy, packing, drainage, transfusion Time and autopsy cause of death—Twelve hours, hæmorrhage, shock, no autopsy

CASE XXIII—White man, twenty-six years old Operation, hours after injury—One and three-quarters Location of wound—Upper right abdomen, lateral Operative findings—Wound of liver, severe hæmorrhage Operation—Exploratory laparotomy, packing, drainage Time and autopsy cause of death—Twenty-six hours, hæmorrhage, shock, hemopneumothorax Wound of right kidney, diaphragm and right lung overlooked

CASE XXIV—White man, thirty-nine years old Operation, hours after injury—? Location of wound—Upper left abdomen, anterior, left chest, anterior Operative findings—Two perforations small intestine, omentum perforated several places, severe hæmorrhage, wound of diaphragm, left lung Operation—Enterorrhaphy, ligation, drainage Time and autopsy cause of death—Three and one-half hours after operation, hæmorrhage, shock Wounds in small intestine overlooked

CASE XXV—Colored man, forty-three years old Operation, hours after injury—Twelve Location of wound—Left abdomen, anterior Operative findings—One perforation of stomach near cardia (anterior wall), wound of diaphragm, left lung, wound in omentum Operation—Gastrorrhaphy, suture of omentum, drainage lesser peritoneal cavity Time and autopsy cause of death—Twelve hours, hæmorrhage, shock Posterior wall stomach, wound of spleen, left kidney all overlooked

CASE XXVI—White man, fifty-two years old Operation, hours after injury—One and three-quarters Location of wound—Upper left abdomen, lateral Operative findings—Wound of liver, two perforations of stomach severe hæmorrhage Operation—Gastrorrhaphy, suture, packing, drainage Complication—Local peritonitis Time and autopsy cause of death—Forty-two hours, peritonitis, hæmorrhage, pneumonia

CASE XXVII—White man, twenty-seven years old Operation, hours after injury—? Location of wound—Upper left abdomen, lateral Operative findings—

Wound of pancreas, two perforations of stomach, two of small intestine, severe hæmorrhage Operation—Gastrorrhaphy, enterorrhaphy, drainage Time and autopsy cause of death—Twelve hours after operation, pulmonary œdema hæmorrhage, shock Wound of liver and left kidney overlooked

CASE XXVIII—White man, twenty-two years old Operation, hours after injury—? Location of wound—Upper left abdomen from back Operative findings—No visceral injury, wound of aorta Operation—Exploratory laparotomy, control of hæmorrhage with clamps, drainage Time and autopsy cause of death—Eight hours, hæmorrhage, shock

CASE XXIX—Colored man, forty-two years old Operation, hour after injury—One Location of wound—Lower right abdomen, lateral, multiple Operative findings—Two perforations stomach, two of jejunum, severe hæmorrhage Operation—Gastrorrhaphy, enterorrhaphy, suture, drainage Time and autopsy cause of death—Three days, hæmorrhage, pneumonia, no autopsy

CASE XXX—Colored man, thirty-eight years old Operation, hour after injury—One Location of wound—Upper left abdomen, lateral to right Operative findings—Wound of liver, gall-bladder, five perforations small intestine, two of transverse colon, severe hæmorrhage Operation—Enterorrhaphy, packing drainage Complication—Peritonitis Time and autopsy cause of death—Five days, peritonitis, hæmorrhage gall-bladder, sutures leaking

CASE XXXI—White man, thirty-eight years old Operation, hours after injury—One Location of wound—Upper left abdomen, anterior Operative findings—Wound of left kidney, two perforations stomach, injury to mesentery, severe hæmorrhage Operation—Nephrectomy, gastrorrhaphy drainage, suture ligation, transfusion Time and autopsy cause of death—One day, hæmorrhage, shock Wound to pancreas overlooked Condition critical at operation

CASE XXXII—Colored man, thirty-seven years old Operation, hours after injury—One and one-quarter Location of wound—Upper right abdomen, anterior Operative findings—Four perforations ileum, three of cæcum, slight hæmorrhage Operation—Enterorrhaphy, suture, drainage Complication—General peritonitis Time and autopsy cause of death—Five days, hæmorrhage, general peritonitis

CASE XXXIII—Colored man, thirty-eight years old Operation, hours after injury—One and three-quarters Location of wound—Upper left abdomen Operative findings—Two perforations jejunum, one of ileum, three of descending colon at mesenteric border, slight hæmorrhage Operation—Enterorrhaphy suture, drainage Time and autopsy cause of death—Four hours, hæmorrhage, alcoholism, shock

CASE XXXIV—Colored man, thirty-three years old Operation, hours after injury—One and one-half Location of wound—Upper right abdomen, anterior, multiple Operative findings—Four perforations small intestine one of cæcum, two descending colon, several of mesentery two of omentum, severe hæmorrhage Operation—Enterorrhaphy, resection small intestine lateral anastomosis, cecostomy, suture, ligation drainage Time and autopsy cause of death—thirty-six hours, hæmorrhage, shock, peritonitis

CASE XXXV—White man, forty years old Operation, hours after injury—Twenty-seven Location of wound—Upper right abdomen, lateral from back Operative findings—Severe wound of liver, four perforations of mesentery, severe hæmorrhage Operation—Laparotomy packing, drainage Complications—Considerable wound bleeding on coughing Time and autopsy cause of death—twelve hours, hæmorrhage, shock, early peritonitis Wound of duodenum overlooked

CASE XXXVI—White woman twenty-five years old Operation, hours after injury—Four Location of wound—Lower abdomen, right chest Operative findings—Wound of liver, two perforations stomach, four of transverse colon, severe hæmorrhage Operation—Gastrorrhaphy, enterorrhaphy, suture, transfusion Complication—Cystitis

## PENETRATING WOUNDS OF THE ABDOMEN

nephritis, hemothorax Time and autopsy cause of death—five days, septicemia<sup>2</sup> hemorrhage, no autopsy

CASE XXXVII—White woman, forty-nine years old Operation, hours after injury —<sup>2</sup> Location of wound—Right abdomen, lateral, right chest Operative findings—Perforation of uterus, four of small intestine, four of large, severe hæmorrhage, wound of bladder and pleura Operation—Enterorrhaphy, suture, drainage Time and autopsy cause of death—ten hours, hæmorrhage, shock

CASE XXXVIII—White man, seventeen years old Operation, hours after injury—Eight<sup>2</sup> Location of wound—Upper right abdomen, anterior Operative findings—Wound of liver, moderate hæmorrhage Operation—Laparotomy, suture, ligation drainage Complication—Wound infected, bronchopneumonia, pleural effusion Time and autopsy cause of death—Twenty-one days, liver abscess, pneumonia, pleurisy, septicemia

CASE XXXIX—White man, twenty-eight years old Operation, hours after injury—Two Location of wound—Upper left abdomen, lateral, left upper abdomen, posterior Operative findings—Wound of liver, left kidney, two perforations stomach, wound of diaphragm, wound of lung, severe hæmorrhage Operation—Gastrorrhaphy suture, drainage Complication—Rupture of wound Time and autopsy cause of death—Eighteen hours, hæmorrhage, shock, early peritonitis

CASE XL—Colored man, twenty-four years old Operation, hour after injury—One Location of wound—Right abdomen, posterior, left chest Operative findings—Wound of liver, right kidney, right lung, diaphragm, severe hæmorrhage Operation—Laparotomy, packing, drainage, transfusion Time and autopsy cause of death—Twenty-four hours, early sepsis, hæmorrhage, shock

CASE XLI—Man Operation, hours after injury—<sup>2</sup> Location of wound—Upper right abdomen, anterior Operative findings—Wound of liver, four perforations large intestine, severe hæmorrhage Operation—Enterorrhaphy, suture drainage Time and autopsy cause of death—Fifteen hours, hæmorrhage, shock, early peritonitis

CASE XLII—White man, thirty-nine years old Operation, hours after injury—<sup>2</sup> Location of wound—Upper left abdomen, lateral, multiple Operative findings—Wound of liver, two perforations stomach, moderate hæmorrhage, diaphragm injured Operation—Gastrorrhaphy, no drainage Time and autopsy cause of death—Three days, bilateral hemothorax peritonitis hæmorrhage

CASE XLIII—Colored man twenty-four years old Operation, hours after injury—Three Location of wound—Upper lower left abdomen, anterior, multiple Operative findings—Three perforations small intestine, two of sigmoid, severe hæmorrhage Operation—Enterorrhaphy, drainage Time and autopsy cause of death—three and one-half hours after operation, hæmorrhage, shock

CASE XLIV—Colored man forty-nine years old Operation, hours after injury—<sup>2</sup> Location of wound—Lower left abdomen, lateral Operative findings—Hematoma retroperitoneal at sigmoid, three contusions serous coat sigmoid, fracture sacrum, slight hæmorrhage Operation—Laparotomy, no drainage, second operation forty days later, thoracotomy Complication—Rupture of wound, lung abscess empyema, septicemia Brown Sequard syndrome Time and autopsy cause of death—Fifty days, septicemia blood culture positive

CASE XLV—Colored man, thirty-two years old Operation, hours after injury—Three and one-half Location of wound—Upper right abdomen, lateral Operative findings—Wound of liver, massive hæmorrhage, cavity filled with blood Operation—Laparotomy, packing, drainage Time and autopsy cause of death—One-half hour after operation, hæmorrhage shock Wound right kidney and stomach overlooked

CASE XLVI—White man, thirty years old Operation hours after injury—Four and one-half Location of Wound—Lower left abdomen Operative findings—Wound of spleen, severe hæmorrhage, wound of diaphragm Operation—Splencotomy

no drainage Time and autopsy cause of death—Fifteen hours after operation, hæmorrhage, shock Wound of liver overlooked

CASE XLVII—Colored man, twenty-one years old Operation, hours after injury—Two Location of wound—Upper left abdomen, multiple Operative findings—Two perforations stomach, two of small intestine, two descending colon, tearing wounds of colon at edge, severe hæmorrhage Operation—Gastrorrhaphy, enterorrhaphy, suture, drainage Time and autopsy cause of death—Twenty-four hours, hæmorrhage, shock, early peritonitis

CASE XLVIII—Colored woman, twenty-six years old Operation, hours after injury—Five Location of wound—Upper left abdomen, lateral Operative findings—Eight perforations ileum, one of mesentery, two of colon Operation—Enterorrhaphy, suture Complication—Local peritonitis, infected wound Time and autopsy cause of death—Nine days, died suddenly, peritonitis, embolus?, leakage from colon repair

CASE XLIX—Colored man, forty-eight years old Operation, hours after injury—Three and one-half Location of wound—Lower right abdomen Operative findings—Penetrating wound of abdomen, severe hæmorrhage, laceration external iliac vein and artery Operation—Laparotomy, ligation, drainage Time and autopsy cause of death—On table, hæmorrhage

CASE L—White man, fifty-two years old Operation, hours after injury—Two, Location of wound—Lower left abdomen, anterior Operative findings—Three perforations ileum, three of mesentery, severe hæmorrhage Operation—Enterorrhaphy, suture, ligation, drainage, transfusion Time and autopsy cause of death—Twelve hours, hæmorrhage, no autopsy

CASE LI—Colored man, twenty-nine years old Operation, hour after injury—One-half Location of wound—Lower right abdomen, lateral Operative findings—Four perforations small intestine, wound of bladder, severe hæmorrhage, fracture right ileum Operation—Laparotomy, marsupialization of bladder Time and autopsy cause of death—Three days, hæmorrhage, sepsis

CASE LII—Colored man, thirty-four years old Operation, hours after injury—Four Location of wound—Left abdomen, lateral, multiple Operative findings—Seven perforations jejunum Operation—Enterorrhaphy, drainage Complication—Infected wound, lobar pneumonia Time and autopsy cause of death—Five days, Pneumonia, peritonitis

CASE LIII—Colored man, thirty-seven years old Operation, hours after injury—Two and one-half Location of wound—Upper left abdomen, anterior, right chest, anterior Operative findings—Six perforations jejunum, one of ascending colon, superior mesentery artery severed, severe hæmorrhage Operation—Laparotomy Complication—Right hemothorax Time and autopsy cause of death—On table, hæmorrhage

CASE LIV—White man, fifty-five years old Operation, hours after injury—Fifty Location of wound—Upper left abdomen Operative findings—One perforation jejunum Operation—Enterorrhaphy Complication—General peritonitis Time and autopsy cause of death—On table, peritonitis, hæmorrhage

CASE LV—Colored woman, twenty-four years old Operation, hours after injury—Two and one-half Location of wound—Right flank Operative findings—Six perforations small intestine, three of descending colon, several lacerations mesentery, severe hæmorrhage Operation—Enterorrhaphy, suture, drainage Time and autopsy cause of death—Nine hours, hæmorrhage, shock, early peritonitis

*Gunshot-wound Injuries—No Operation—Death*

CASE I—White boy, eighteen years old Condition on admission—Moribund Time and autopsy cause of death—Ten minutes, hæmorrhage and shock, wound of pyloric end of stomach, vessels in front of spine

CASE II—White man, twenty-six years old Condition on admission—Moribund

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Time and autopsy cause of death—Five minutes, hæmorrhage and shock, branches of aorta severed

CASE III—White man, forty years old Condition on admission—Moribund Time and autopsy cause of death—Few minutes, hæmorrhages and shock, six perforations small intestine, six in mesentery

CASE IV—Colored man, thirty-two years old Condition on admission—Moribund Time and autopsy cause of death—?, hæmorrhage and shock, injuries to stomach, diaphragm, liver, pancreas and duodenum

CASE V—Colored woman Condition on admission—Moribund Time and autopsy cause of death—Forty minutes, hæmorrhage and shock, left pleural cavity filled with blood, wounds of abdomen, chest and left hand Six hundred cubic centimetres N S S given intravenously

CASE VI—White man, twenty-eight years old Condition on admission—Moribund Time and autopsy cause of death—Few minutes, hæmorrhage and shock, no autopsy

CASE VII—White man, fifty years old Condition on admission—Suicide Time and autopsy cause of death—Five days, cardiac decompensation, passed bloody urine, pneumonia peritonitis ?, no autopsy

CASE VIII—Colored woman, thirty-two years old Condition on admission Moribund Time and autopsy cause of death—Twenty-six hours, shock and multiple injuries, two perforating wounds of cranium, two penetrating wounds of abdomen, no autopsy

CASE IX—White man Condition on admission—Moribund Time and autopsy cause of death—Thirty minutes, hæmorrhage and shock, wound of right lung, several of liver, multiple of intestines, wounds of vessels in front of spine

CASE X—White man, forty-eight years old Condition on admission—Moribund Time and autopsy cause of death—Few minutes, hæmorrhage and shock, perforation of intestines, liver and gall-bladder

CASE XI—Colored man, thirty-four years old Condition on admission—Moribund Time and autopsy cause of death—Few minutes, hæmorrhage and shock, injury to left lung, both ventricles of heart, liver, vena cava

CASE XII—White man, thirty-one years old Condition on admission—Moribund Time and autopsy cause of death—Few minutes, hæmorrhage and shock, injury to liver, diaphragm

CASE XIII—White man, twenty-five years old Condition on admission—Moribund Time and autopsy cause of death—Five minutes, hæmorrhage and shock, no autopsy

CASE XIV—White man, thirty-one years old Condition on admission—Moribund Time and autopsy cause of death—Few minutes, hæmorrhage and shock, iliac vessels severed

CASE XV—Colored man, twenty-three years old Condition on admission—Moribund Time and autopsy cause of death—One hour, hæmorrhage and shock, wounds of liver and pancreas

CASE XVI—Colored man, fifty years old Condition on admission—Moribund Time and autopsy cause of death—One hour, hæmorrhage and shock, iliac vessels severed

CASE XVII—White man, thirty-four years old Condition on admission—Moribund Time and autopsy cause of death—Two and one-half hours, hæmorrhage and shock, wounds of liver and stomach, did not respond to resuscitating measures

CASE XVIII—White man, thirty years old Condition on admission—Moribund Time and autopsy cause of death—One hour, hæmorrhage and shock, abdomen filled with blood

CASE XIX—White man, thirty-two years old Condition on admission—Moribund Time and autopsy cause of death—One hour, hæmorrhage and shock, no autopsy One thousand cubic centimetres N S S given

## BILLINGS AND WALKLING

CASE XX—White man, twenty-three years old Condition on admission—Moribund Time and autopsy cause of death—Two hours, hæmorrhage and shock, large liver wound, grazed side of upper lumbar spine, blood in abdomen

The liver was injured in 22 cases (no associated injuries in 11)  
 The stomach was injured in 9 cases (no associated injuries in 1)  
 The small intestine was injured in 18 cases (no associated injuries in 8)  
 The large intestine was injured in 8 cases (no associated injuries in 3)  
 The spleen was injured in 3 cases (no associated injuries in 2)  
 The pancreas was injured in 2 cases  
 The kidney was injured in 3 cases (no associated injuries in 1)  
 The bladder was injured in 3 cases (no associated injuries in 2)  
 The ureter was injured in 1 case

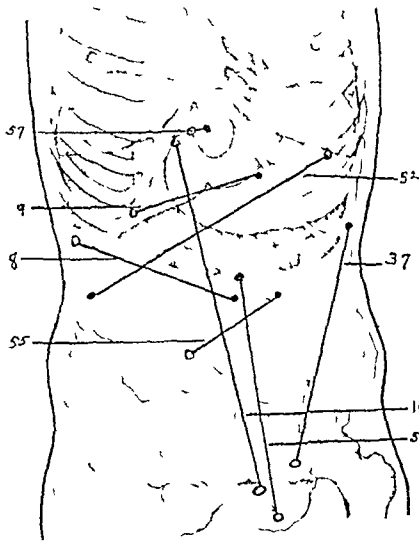


FIG 1—Gunshot wounds—operative recoveries ●—Wound of entrance ○—Wound of exit ○—Posterior wound Numbers refer to numbers in respective charts

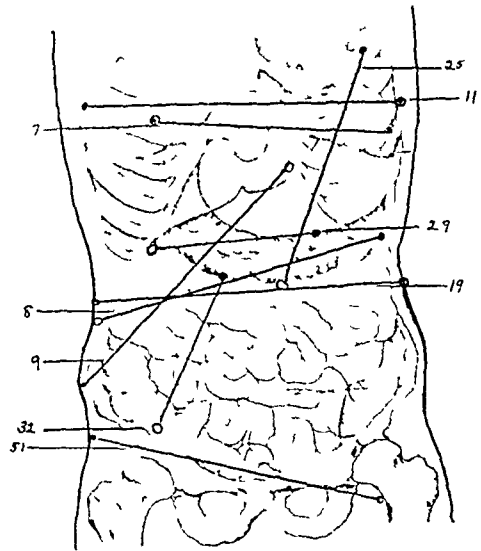


FIG 2—Gunshot wounds—operative deaths ●—Wound of entrance ○—Wound of exit ○—Posterior wound Numbers refer to case numbers in respective charts

Resection of the small intestine was done in 3 cases (with end-to-end anastomosis in two and lateral anastomosis in one) A lateral anastomosis without resection was done in one case Splenectomy was done in one patient who developed tertian malaria during convalescence Nephrectomy was done in one case Two cases were transfused, and a re-infusion or replacement of 300 cubic centimetres of blood was done in a case of liver injury

Ten cases suffered wound infection, 3 of these occurring in 6 patients whose wounds were closed without drainage Three had general peritonitis, one had local peritonitis, and four had pneumonia

Two patients recovered without operation who were thought to have had visceral injury One was in a state of collapse on admission, with all the signs of massive internal hæmorrhage The pulse was imperceptible, blood

pressure 60/40, and his general condition so serious that operation was postponed and conservative treatment instituted. His condition had improved so much at the end of twenty-four hours that conservative treatment was continued. The injury was thought to have been one of the spleen. He developed a small left pleural effusion (hæmolytic streptococci on culture from aspirated fluid) with moderate fever for four weeks, and recovered in thirty-eight days. In reference to the other case, it was thought that he did not suffer intra-abdominal injury at the time of admission, but he vomited a considerable quantity of blood on the third day, and developed symptoms of peritonitis with obliteration of liver dullness, marked rigidity and tenderness, when a diagnosis of perforation of stomach was made.

Conservative treatment was continued with gradual improvement of his symptoms until recovery.

*Gunshot Deaths*—In this group there were 75 cases, 20 of which were not operated upon for the reason that they were moribund on admission or were never in condition for operation—the table is explanatory. Fifty-five cases were operated upon, 28 of which died within twenty-four hours. Hæmorrhage was severe in 42 cases, and was severe in all who died within twenty-four hours. Fifty-three cases suffered visceral injury. In 2 cases there was no visceral injury, but in each of these there was large blood-vessel damage (abdominal aorta, one, right external iliac vessels, one). It will be seen in the tabulations that multiple visceral and associated visceral injury was present in nearly all of the cases. In the majority of these it was of an extensive nature.

The liver was injured in 23 cases (no associated injuries in 2)

The stomach was injured in 16 cases

The small intestine was injured in 30 cases (no associated injuries in 10)

The large intestine was injured in 16 cases (no associated injuries in 1)

The kidney was injured in 7 cases

The spleen was injured in 3 cases

The pancreas was injured in 3 cases

The bladder was injured in 2 cases

The external iliac vessels were injured in 3 cases (no associated injuries in 1)

The abdominal aorta was injured in 1 case

There were 18 cases with combined abdominal and chest injuries. Five patients were transfused. Intestinal resection was done in 2 cases, nephrectomy in one, and splenectomy in one.

We have autopsy reports on 49 of the 55 gunshot operative deaths checked against operative findings in tabulation of cases. The records revealed that in 9 cases visceral injuries of one kind or another had been overlooked at the time of operation. It is difficult to say what part was played by the unrepaired injuries in the cause of death, but we believe it was an important one. Five of the 9 cases died within twenty-four hours, all attributed to hæmorrhage and shock. The overlooked injuries in these cases included stomach and right kidney in one (45)\*, stomach (posterior

\* Refers to case numbers in tabulation



wall), spleen and left kidney in one (25)\*, duodenum in one (35)\*, pancreas in one (31)\*, and left kidney and liver in one (27)\*. In another case with severe hæmorrhage from a liver injury, wounds of the right kidney, diaphragm and right lung (23)\* were overlooked. Death occurred in twenty-six hours from hæmorrhage and shock. In another case with overlooked wounds of stomach, spleen and diaphragm (11)\* death occurred in forty hours from hæmorrhage and shock. A wound of the pancreas (14)\* was overlooked in a case of liver, diaphragm and cord injury with severe hæmorrhage. Death occurred in sixteen days from peritonitis and urinary-tract infection. Another case (7) in whom a wound of the liver and posterior wall of the stomach was overlooked lived for twenty-four days. Sub-phrenic abscess and sepsis was the cause of death. In three cases (4, 21, 48)\* that died of peritonitis or infection, leakage had occurred subsequent to the repair of perforating wounds of the intestine (duodenum, 1, colon, 2), and probably in each instance was a big factor, if not the direct cause, of death.

In regard to the overlooked injuries, we believe that their occurrence is more common than is generally supposed. The most convincing proof of the correctness of this statement will come from an autopsy "check-up" with operative findings. Those who have had experience in dealing with injuries such as are represented in this group of operative deaths will appreciate the difficulties often encountered at operation, and the ease with which such an error may be committed. The 9 cases in which lesions were overlooked were in very critical condition at the time of operation. Several of them had failed to show any reaction from shock after the use of the usual anti-shock measures, and their condition had rapidly changed from bad to worse because of continued bleeding, the operation having been done primarily for the control of hæmorrhage. Under such circumstances the amount of the anæsthetic and the time required for the operation assume more than the usual importance in the result. It is in such cases that blood transfusion will be of the greatest value. By this means the patient's condition may be so improved that the surgeon can go ahead with a thoroughly satisfactory exploration, and a careful repair of all visceral injuries. The average time between injury and operation for the whole series was a little over three hours, which we believe is early enough. More errors are made in operating too soon than too late. It is important to give the patient a chance to react from shock. Hæmorrhage must be differentiated from shock, and a distinction must be made in the patients whose failure to react is due to continued bleeding. If the pulse is rapid (120 or above), and its rate is not reduced by resuscitating shock measures, hæmorrhage of a serious character may be suspected.

In conclusion we suggest, *first*, the more general and routine use of blood transfusion, and in selected cases of severe hæmorrhage without hollow visceral injury, the re-infusion or replacement of blood can be done to great advantage. *Second*, the adoption of measures calculated to further reduce

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\* Refers to case numbers in tabulation

## PENETRATING WOUNDS OF THE ABDOMEN

the incidence of intra-abdominal and wound infection *Third*, thorough exploration of every case for visceral injury, particularly of the upper abdomen where the risk of overlooking injuries is greatest

We wish to express our appreciation to Dr W S Wadsworth, coroner's physician of Philadelphia, for the high percentage of autopsy records contained in this series

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# THE EVALUATION OF RESULTS IN 324 GASTRIC AND DUODENAL ULCERS<sup>1</sup>

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IN VIEW of the fact that most internists and surgeons are not in accord as to the permanency of cure after either medical or surgical treatment of ulcers, it was decided by Dr Carl G Burdick, Director of the Fourth Surgical Division, and Dr Alexander Lambert, Director of the Fourth Medical Division, Bellevue Hospital, to organize a combined clinic for the study of this disease. This clinic was started in January, 1928 and the cases admitted for the first three years have been reviewed. During this period we have observed 324 ulcers and the cases have been divided into the month and year of admission to determine whether there has been a seasonal relationship to ulcer symptomatology. It was felt that by taking the admission to the clinic one could determine more accurately the month in which the patient had periodicity of pain, rather than by relying on the history, as all of these patients live in Greater New York and would enter the clinic when their pain was most intense. In reviewing the histories with symptoms extending over eight to ten years, the patient usually cannot recall the month, or even the exact year, of onset. In our review, there was no seasonal relationship except a slight decrease in the months of August and September. (See Table I.) The reason for the large number of admissions for January and February of 1928 was due to the fact that all ulcer cases treated on the Fourth Medical and Surgical Divisions for the past ten years were written to and asked to return for observation.

It is of interest to determine whether the incidence of ulcer is on the increase or decrease, and an analysis of the total number of ulcers and the total admissions to Bellevue Hospital, from 1910 to 1930 inclusive, reveals an increase in the total number of ulcer cases and when worked out on a percentage basis also reveals an increase which is illustrated in Table II. These statistics were taken from the annual report of the hospital. One question that naturally arises is whether the diagnosis is not more accurately made now than in the beginning of the series. There seems to be little doubt that the roentgen diagnosis is more accurate at present, but Hirsch introduced the double meal method of gastro-intestinal examination at Bellevue Hospital in 1910, but, of course, there were fewer cases to examine then than now. Also, refinements have been made in the technic of examination. The assumption that as many ulcers existed in 1910 as in 1930, but were unrecognized at that time, would lead one to believe that the complications of perforation and hæmorrhage should have been much more common twenty years

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<sup>1</sup> Read by title before the American Gastro-Enterological Association, May 5, 1931

## TREATMENT RESULTS GASTRIC ULCERS

ago than now, but it is interesting to note on reviewing the perforated and hæmorrhaged cases on the Fourth Surgical Division that these complications have shown a marked increase in recent years. There have been 116 acute perforated ulcers on the Fourth Surgical Division from 1911 to 1930, inclusive, which is shown in Table III. It can be seen that from 1923 on there has been a marked increase in this complication and also during the past twenty years there have been fifty-seven cases of bleeding ulcer with an increase during the past three years. (See Table IV.) How to explain this apparent increase in the total number of cases and complications in recent years is very difficult, but the figures are taken from a city institution and it is fair to assume that the same type of patient was seen twenty years ago as at the present time and their habits of living have not changed appreciably during this period.

TABLE I  
*Shows Month and Year of Admission to Clinic*

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Totals
1928	15	20	10	11	17	6	10	2	7	3	11	12	124
1929	7	5	13	10	11	13	9	8	3	7	4	10	100
1930	11	5	13	8	8	4	4	3	6	17	13	8	100
Totals	33	30	36	29	36	23	23	13	16	27	28	30	324

TABLE II  
*Total Number of Admissions with Percentage of Ulcer Cases*

Year	Gastric	Deaths	Duodenal	Deaths	Total ulcers	Total admissions	Percentage of cases with ulcers
1910	29	4			33	36,330	09
1911	48	6			54	37,578	14
1912	33	8			47	40,296	11
1913	56	10			66	41,248	16
1914	55	8			53	43,297	12
1915	73	7	23	4	107	44,485	24
1916	108	16	50	4	178	45,422	39
1917	88	17	62	7	174	45,470	38
1918	89	11	55	4	159	42,563	37
1919	71	6	34	1	112	38,850	30
1920	61	10	43	3	115	38,945	30
1921	59	15	56	5	135	43,597	31
1922	79	13	81	7	180	45,671	40
1923	75	13	101	10	199	45,258	44
1924	137	9	148	5	299	49,344	61
1925	119	16	164	10	309	49,511	62
1926	115	16	138	8	277	48,293	57
1927	88	20	151	11	270	49,986	54
1928	143	21	198	11	373	52,336	71
1929	114	21	158	17	310	52,643	59
1930	123	21	212	10	335	57,292	59

J WILLIAM HINTON

This report will not take up the end-results of medical or surgical management as it is felt that no accurate conclusions can be drawn from either

TABLE III  
*Showing Year of Perforation*

Year	Died	Improved	Total
1911	0	1	1
1912	2	0	2
1913	1	2	3
1914	0	4	4
1915	2	1	3
1916	0	2	2
1917	3	3	6
1918	1	4	5
1919	1	3	4
1920	0	3	3
1921	1	2	3
1922	1	4	5
1923	3	6	9
1924	1	7	8
1925	0	8	8
1926	3	5	8
1927	0	9	9
1928	0	9	9
1929	1	12	13
1930	2	9	11
Total	22	94	116

treatment unless the patient has been observed for at least ten years, and frequently examined during this time The patients seen in the clinic during

TABLE IV  
*Year in Which Hemorrhage Occurred*

1911	4	1921	1
1912	1	1922	0
1913	2	1923	1
1914	1	1924	3
1915	1	1925	2
1916	1	1926	2
1917	0	1927	3
1918	1	1928	10
1919	0	1929	13
1920	0	1930	11
Total			57

past three years have been grouped as to location of lesion which is illustrated in Table V During this period, 324 patients were seen and they have made a total of 3,452 visits There were 214 unoperated cases in this group and

# TREATMENT RESULTS GASTRIC ULCERS

TABLE V  
*Shows Location of Ulcer*

Duodenal	Gastric	Pyloric	Double ulcers (stomach and duodenum)	Total
270	34	14	6	324

we have referred only twenty for operation as the one indication for surgery is pain which cannot be relieved by different methods of medical care. During the three years there have been six acute perforated ulcers and five hæmorrhages occurring in patients under medical treatment. Of the perforations, two resulted in death and the others are progressing satisfactorily after simple closure. The bleeding cases are progressing satisfactorily after transfusions and conservative care. The question of carcinoma arising in ulcers is always an interesting topic for discussion. We have treated all ulcers, whether gastric or duodenal, by medical care and have been encouraged by the prompt response that is obtained in gastric lesions under medical treatment. Because the patient has an ulcer of his duodenum or stomach is no reason why he cannot develop a carcinoma at some other site, and we have two cases which have done so while under observation. First Male, thirty-seven years of age, who had a duodenal ulcer and had been treated in several hospitals before coming under our care and on admission had a duodenal lesion and after being under treatment for about one year was feeling greatly improved and returned to Poland for a visit of several months. On his return he complained of upper abdominal pain. Reexamination revealed a carcinoma involving the lesser curvature and at operation the growth was found to be inoperable. There was no relation between the carcinoma in the stomach and the duodenal ulcer from which he had suffered and a careful review of the literature<sup>1</sup> pertaining to duodenal ulcer undergoing carcinomatous degeneration has failed to reveal a definitely proven case of such a complication occurring, although there are any number of primary carcinomas of the duodenum reported.

Another man, forty-two years of age, having had two negative gastro-intestinal X-ray series, was operated upon for an epigastric hernia for the relief of abdominal pain and in June, 1928, three months after the operation, he came under our observation, at which time he had a pyloric ulcer. He did very well under medical treatment and one year later the gastro-intestinal X-ray series revealed the pyloric ulcer healed but another lesion on the lesser curvature at the junction of pars media and pylorica, which was pronounced an ulcer. The patient left town shortly after and was operated upon in another city, due to pain from which he was suffering, and the operating surgeon found what he took to be a carcinoma or a very large indurated ulcer and he did not think a resection advisable, as the growth was fixed, but did a gastroenterostomy. This patient is being followed at the present time and has a definite carcinoma involving his entire lesser curvature. In view of the

history of this patient, it would seem justifiable to assume that when a patient is under treatment for an ulcer of his stomach or duodenum, and the original lesion has responded satisfactorily, and the patient develops a second lesion in the stomach, that we are dealing with a primary carcinoma and not an ulcer, as it has been our experience that gastric ulcers heal much more readily under medical care than duodenal ulcers and therefore it is not logical to assume an ulcer would develop in some other site after the original one has healed and the patient still under treatment

There have been 110 cases operated upon that are now under observation. Of this number fifty-seven were operated upon for chronic ulcers and most of these previously to 1928, as we have referred only twenty patients for operation during the past three years. Several of these patients are more than ten years post-operative, but we are not attempting to call them cured. In studying the unsatisfactory results we find that most of the cases operated upon early in the disease will not do well regardless of the type of operation, but the cases that have had prolonged medical care, and develop an associated pancreatitis, usually do beautifully following a simple gastroenterostomy. Of the chronic ulcers that we are following, all were not operated upon at Bellevue Hospital but came there for relief of symptoms after having been operated upon in other institutions. There have been forty-seven gastroenterostomies and three partial gastrectomies, six Horsley's and one Finney pyloroplasty. We have had seven marginal ulcers under our observation. One patient, a man twenty-five years of age, was operated upon three months after the onset of abdominal pain and six months after his operation he had a marginal ulcer and within twelve months from the onset of the original pain he had been operated upon a second time when a partial gastrectomy was done for the marginal ulcer and the patient died as a result of same. Another man thirty-nine years of age, originally had a gastroenterostomy followed by a marginal ulcer. A second operation disconnected the gastroenterostomy. His pain returned and one year later he had a plastic operation for the duodenal ulcer but the pain persisted and two years later he had a second gastroenterostomy and it is now nearly two years since this operation and the patient has been symptom-free. This leaves five cases that had marginal ulcers which are being treated medically and their symptoms had been present from six to eighteen months before starting treatment and four out of the five patients are greatly improved and practically symptom-free under medical treatment, while the symptoms of one remain unchanged. There are seven patients who have been referred for operation who have had an associated chronic pancreatitis. All of these patients are symptom-free with a simple gastroenterostomy, their follow-up varying from six months to three years. Of the forty-six acute perforations that are being followed in the clinic, most of them are doing quite satisfactorily following a simple closure but four have undergone a second operation for pyloric stenosis one having to submit to a second operation within ten months, while the longest went five and a half years following the perforation, but it is felt that these patients should

## TREATMENT RESULTS GASTRIC ULCERS

have as little surgery as possible at the time of the original operation. Seven patients have been operated upon for bleeding ulcers. It is interesting to note that one case, a man twenty-five years of age, had a pyloroplasty, two years later a partial gastrectomy and since that has had profuse hæmorrhages, while a second man, fifty-nine years of age, had a profuse gastric hæmorrhage every one or two years over a six-year period, then was operated upon and a gastroenterostomy done. He continued to have hæmorrhages every year for another three years when he was re-operated upon, the second operation being a simple exploratory, finding the gastroenterostomy stoma normal and a duodenal ulcer present and the abdomen was closed without further surgery. Since the second operation, which was three and a half years ago, the patient has not bled. Bleeding ulcers constitute a very difficult group to treat and it is even more difficult to draw conclusions from their study. In a previous paper<sup>2</sup> it was stated that most cases of bleeding ulcers should have transfusions and conservative treatment following the first or second hæmorrhage, but after they have had several recurrent hæmorrhages they should be operated upon as it is known that cases of bleeding ulcers will result in fatalities in spite of transfusions and other supportive measures. Also, some cases will continue to bleed after operation, and this includes every type of operation from pyloroplasties to sub-total gastrectomies.

*Comment* —From the study of this group of cases one can see that a large percentage of both gastric and duodenal ulcers occurring in patients who seek treatment in a city hospital can be carried along under medical care with very satisfactory results, and if one will refrain from operating upon these patients early in the course of the disease and refer them only after every attempt at medical treatment has failed, the surgical results will be most gratifying with conservative types of operation, either gastroenterostomy or in selected cases of pyloroplasties. Any attempt to call a patient cured after either medical or surgical treatment unless followed for a ten-year period, and frequently examined, is most misleading.

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# VOLVULUS OF A SIGMOID MEGACOLON

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Volvulus of the sigmoid loop of large intestine is apparently not an uncommon condition. It is described in text-books of diseases of the large bowel and is a well-recognized clinical entity. Volvulus of a giant sigmoid or megacolon, however, appears to be a much rarer condition. A recent experience with the latter type of volvulus and the collection of some sixty-three similar cases in the literature seem to justify the following report.



FIG 1—Volvulus of the sigmoid megacolon just before resection and two days after the original exploration

CASE REPORT—The patient was an Irish boy of eighteen who was admitted to the First Surgical Division of Bellevue Hospital with a chief complaint of pain in the abdomen of four days' duration. He had not moved his bowels in eight days. The present illness started with a slight pain about the umbilicus which became increasingly severe during the next four days. There was gradually increasing distension of the abdomen. There were slight nausea and vomiting the first day of the illness which returned the day of admission to the hospital. The patient had been unable to move his bowels in the preceding eight days. The administration of large doses of Epsom salts accompanied by numerous enemas failed to relieve this condition.

## SIGMOID MEGACOLON VOLVULUS

There was a past history of constipation since birth, the patient frequently going four to five days without a bowel movement. There had been several mild attacks of abdominal pain when the constipation was more marked than usual, this pain lasting two to three hours. His general health had always been excellent.

On physical examination the patient did not appear acutely ill. The abdomen was moderately distended. There was tenderness to palpation in all four quadrants, most marked about the umbilicus. There was moderate spasm of both rectus muscles. There was no visible peristalsis and no tumor mass could be felt. There was obliteration of



FIG. 2.—Barium enema two months postoperative showing site of anastomosis.

liver dullness. The patient was not vomiting. Temperature 99.6°. Pulse 104. Respirations 24. The white blood count was 9,200 with 84 per cent polymorphonuclears.

Under a gas, oxygen and ether anæsthetic a right rectus incision was made. There presented in the wound a tremendously dilated structure that at first was thought to be stomach. As this organ almost filled the entire peritoneal cavity, a 20 F catheter was inserted by means of a purse-string suture and quantities of gas and fecal material escaped. It was then found that we were dealing with a volvulus of an enormously hypertrophied and distended sigmoid loop. It was twisted two and one-half times clockwise about its mesentery. The entire sigmoid was enlarged to about five times its normal size and its wall markedly thickened. This enlargement started at the beginning of the iliac colon and continued down to the recto-sigmoid junction. The rectum was dilated but still con-

siderably smaller than the sigmoid. The remainder of the large intestine was distended but did not resemble the pelvic colon in any way. The wall of the involved loop was oedematous, purplish in color but not gangrenous and assumed its normal appearance as soon as the volvulus was relieved. The sigmoid mesocolon was extremely long, very much thickened and oedematous.

The giant sigmoid was then brought out on the abdominal wall and the first stage of a Mickulicz resection was done. The proximal and distal loops were united with interrupted sutures for a distance of three inches below the abdominal wall. By doing this we were able to exteriorize all of the pathologic bowel except that portion of the iliac colon which had no mesentery. The two united limbs were then sutured to the parietal peritoneum at the margins of the wound. The megacolon was then lifted in a direction perpendicular to the patient and an attempt was made to squeeze as much of the blood back into the general circulation as possible. A large tape was then passed



FIG. 3—A comparison between a barium enema three and one half months post-operative (left) and that of a normal individual (right).

about the base of the megacolon one inch anterior to the abdominal wall and tied as tight as possible, thus strangulating the loop. A 24 F catheter was then inserted into the proximal loop to allow for the escape of gas and fecal contents.

The immediate post-operative reaction was excellent. Large amounts of gas and fecal material drained through the catheter.

Two days later the megacolon was resected by means of the actual cautery, level with the abdominal wall (Fig. 1). At this time the very large vessels of the mesentery were tied.

Seven days post-operative a Mickulicz clamp was inserted in the shot-gun barrel openings. Twenty-four days post-operative there was a large opening between the proximal and distal loops. At this time several large masses of impacted feces were removed manually from the rectum. On the forty-second post-operative day the colostomy was closed. At the present time, seven months after operation, the patient is perfectly well and having one normal bowel movement a day. A barium enema two months post-operative shows some enlargement of the bowel above the site of anastomosis and some

## SIGMOID MEGACOLON VOLVULUS

dilatation of the rectum (Fig 2) A later barium enema, three and one-half months post-operative shows some dilatation still present Figure 3 is a comparison of the large bowel of the patient with that of a normal individual of the same age As at operation the large intestine above the iliac colon did not show signs of hypertrophy, we were rather surprised to note the dilatation evident in Figs 2 and 3 The interpretation of this finding is rather difficult It is impossible to say whether this patient will eventually develop a true Hirschsprung's disease or whether the dilatation now present is merely a distension of the large bowel and will in time disappear

*Pathology*—The specimen (Fig 4) measures 54 centimetres in length, 25 centimetres

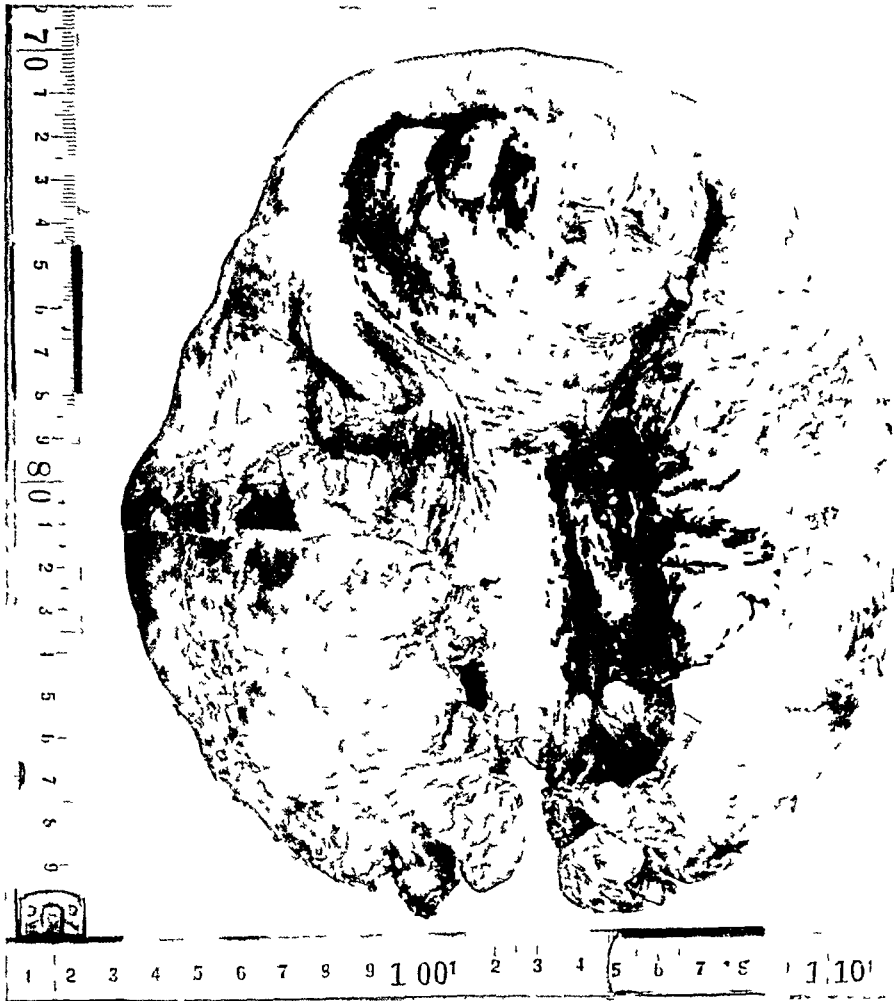


FIG 4—The sigmoid megacolon

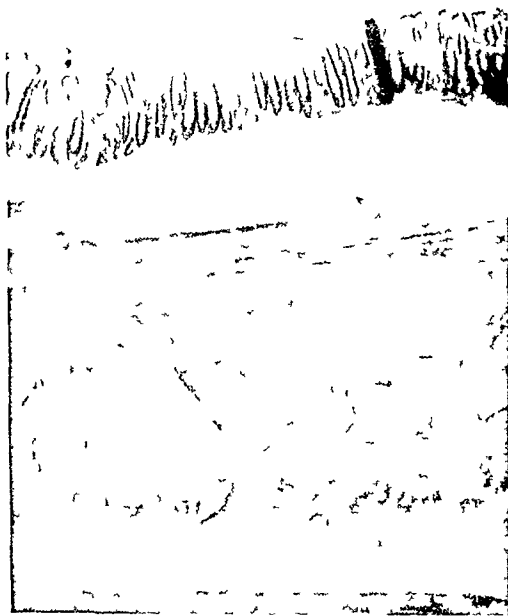
in circumference, and the wall is 10 millimetres in thickness A comparison (Fig 5) between a section of the megacolon and a piece of sigmoid from a normal young adult shows the remarkable hypertrophy of all coats, especially the layer of circular muscle There is a diffuse polymorphonuclear infiltration throughout the entire wall

TABLE I

Pauchet in 1900	sex—?	—13 years old	Operative procedure, detorsion, result, death
Frommer, A., in 1901	male,	19 years old,	180 degrees of volvulus Operative procedure,
			ileo-sigmoidostomy, result, recovery
Boeckel, J., in 1903	male,	2½ years old,	180 degrees of volvulus Operative procedure,
			resection, end-to-end, result, recovery
Lane, A., in 1904	female		Operative procedure, resection, end-to-end, result, recovery

## CARNES WEEKS

- Pauchet in 1904 male, 35 years old Operative procedure, resection, end-to-end, result, death
- Garre in 1905 male, 28 years old, 180 degrees of volvulus Operative procedure, detorsion and fixation, result, recovery
- Bloodgood, J C, in 1906 male, 65 years old Operative procedure, resection, side-to-side, result, recovery
- Tuffier in 1907 male, 60 years old Operative procedure, colostomy, result, death
- Feldman, M, in 1908 male Operative procedure, colostomy, result, death
- Lecene, P, in 1908 male, 60 years old, 90 degrees of volvulus Operative procedure, detorsion and fixation, result, recovery
- Schmieden in 1908 male, 20 years old Operative procedure, colocolostomy, result, recovery
- Jeannel in 1908 male, 40 years old, 360 degrees of volvulus Operative procedure, colostomy, result, recovery
- Bessel-Hagen in 1908 male, 6 years old Operative procedure, Mickulicz, result, recovery



Konjetzny, G, in 1910 male, 51 years old, 450 degrees of volvulus Operative procedure, Mickulicz, result, recovery

Konjetzny, G, in 1910 male, 24 years old, 180 degrees of volvulus Operative procedure, Mickulicz, result, recovery

Konjetzny, G, in 1911 male, 3 years

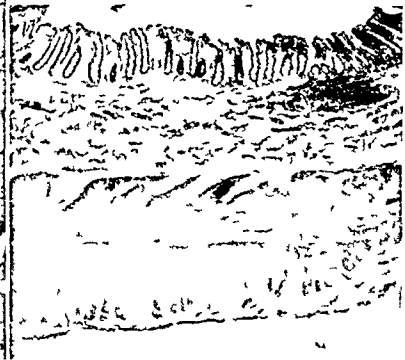


FIG 5—Comparison between the walls of the megacolon (left) and of normal sigmoid (right)  
( $\times 14$ )

old, 180 degrees of volvulus Operative procedure, resection, end-to-end, result, recovery

Clermont in 1911 male, 61 years old, 180 degrees of volvulus Operative procedure, colocolostomy, result, recovery

Kraske in 1911 male, 27 years old, 360 degrees of volvulus Operative procedure, Mickulicz, result, recovery

Critchlow, J F, in 1912 male, 42 years old Operative procedure, resection, end-to-end, result, death

Gregoire, R, in 1912 female, 50 years old, 360 degrees of volvulus Operative procedure, resection, end-to-side, result, recovery

Wideroe, S, in 1912 male, 98 years old, 180 degrees of volvulus Operative procedure, resection, side-to-side, result, recovery

Lecene, P, in 1913 female, 42 years old Operative procedure, resection, end-to-end, result, death

Delbet in 1913 female, 7 years old Operative procedure, detorsion, result, death

Savariaud in 1913 male, 18 years old Operative procedure, detorsion, result, recovery

# SIGMOID MEGACOLON VOLVULUS

- Viguier in 1913 female, 42 years old, 360 degrees of volvulus Operative procedure, resection, end-to-end, result, recovery
- Payr, E, in 1916 male, 51 years old Operative procedure, detorsion and fixation, result, recovery
- Horhammer in 1917 male, 54 years old Operative procedure, Mickulicz, result, recovery
- Rumpel in 1917 male, 42 years old Operative procedure, resection, result, death
- Rumpel in 1917 female, 49 years old, 270 degrees of volvulus Operative procedure, Mickulicz, result, recovery
- Judd, E S, in 1917 male, 55 years old Operative procedure, Mickulicz, result, ?
- Lecene, P, in 1918 male, 76 years old Operative procedure, detorsion and fixation, result, recovery
- Nandrot in 1918 male, 31 years old Operative procedure, Mickulicz, result, recovery
- Sencert and Simon in 1919 male, 55 years old Operative procedure, resection, end-to-end, result, ?
- Lecene, P, in 1919 male, 49 years old Operative procedure, detorsion, result, recovery
- Luken in 1919 female, 58 years old, 180 degrees of volvulus Operative procedure, Mickulicz, result, ?
- Payr, E, in 1919 male, 61 years old, 90 degrees of volvulus Operative procedure, detorsion, result, death
- Payr, E, in 1919 male, 51 years old, 180 degrees of volvulus Operative procedure, Mickulicz, result, recovery
- Rumpel in 1919 female, 40 years old, 270 degrees of volvulus Operative procedure, Mickulicz, result, recovery
- Hohlbaum in 1919 male, 29 years old, 180 degrees of volvulus Operative procedure, Mickulicz, result, death
- Guimbilot in 1919 female, 26 years old, 630 degrees of volvulus Operative procedure, resection, end-to-end, result, recovery
- Schaaning, G, in 1920 male, 45 years old, 360 degrees of volvulus Operative procedure, resection, end-to-end, result, death
- Frank, E, 1921 female, 57 years old, 180 degrees of volvulus Operative procedure, resection, side-to-side, result, recovery
- Delagemere in 1921 male, 45 years old, 720 degrees of volvulus Operative procedure, Mickulicz,\* result, death
- Delagemere in 1921 male, 54 years old Operative procedure, resection, end-to-end result, recovery
- Savariaud in 1921 male, 36 years old Operative procedure, Mickulicz,\* result, death
- Migimac, G, in 1921 male, 46 years old Operative procedure, Mickulicz, result, death
- Savariaud in 1921 male Operative procedure, Mickulicz, result, recovery
- Edwards, S R, in 1921 female, 47 years old Operative procedure, resection, side-to-side, result, recovery
- Edwards, S R, in 1921 female, 65 years old Operative procedure, resection, side-to-side result, recovery
- Willis, M, in 1922 female, 45 years old Operative procedure, resection, end-to-end result, recovery
- Leflaive, P G, in 1922 female, 36 years old, 180 degrees of volvulus Operative procedure Mickulicz, result, recovery
- Franke in 1923 male, 78 years old, 180 degrees of volvulus Operative procedure, resection, side-to-side, result, recovery
- Roux-Berger, J L, in 1923 female, 30 years old Operative procedure, Mickulicz, result recovery
- Launay in 1923 female, 50 years old Operative procedure, resection, end-to-end, result, recovery
- Launay in 1924 male, 26 years old Operative procedure, resection, end-to-end, result, recovery

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Bonmot in 1924 male, 48 years old, 270 degrees of volvulus Operative procedure  
 Mickulicz, result, recovery  
 Hertz, J, in 1924 male, 60 years old, 900 degrees Operative procedure, Mickulicz,  
 result, recovery  
 Launay in 1925 male, 68 years old Operative procedure, resection, end-to-end, result,  
 recovery  
 Rochet in 1926 male, 48 years old, 540 degrees of volvulus Operative procedure, resec-  
 tion, result, death  
 Aumont in 1928 female, 30 years old, 90 degrees of volvulus Operative procedure,  
 Mickulicz, result, recovery  
 Brocq, P, in 1929 female, 34 years old, 720 degrees of volvulus Operative procedure,  
 Mickulicz, result, recovery  
 Weeks, C, in 1930 male, 21 years old, 900 degrees of volvulus Operative procedure,  
 Mickulicz, result, recovery  
 Roux de Brignolles, female, 50 years old Operative procedure, detorsion and fixation,  
 result, recovery  
 Michon, female, 79 years old Operative procedure, sigmoidostomy, result, recovery  
 Heller, A, in 1904 male, 45 years old Operative procedure, autopsy  
 Vene, M, in 1908 male, 72 years old, 90 degrees of volvulus Operative procedure, autopsy  
 Konjetzny, G, in 1908 male, 4 months old, 180 degrees of volvulus Operative procedure,  
 autopsy  
 Kleinschmidt, H, in 1910 male, 5 months old, 90 degrees of volvulus Operative pro-  
 cedure, result, autopsy  
 Konjetzny, G, in 1911 female, 9 months old, 180 degrees of volvulus Operative proce-  
 dure, autopsy  
 Wiedhopf, O, in 1913 male, 70 years old, 180 degrees of volvulus Operative procedure,  
 autopsy  
 Schaaning, G, in 1919 female, 61 years old, 360 degrees of volvulus Operative pro-  
 cedure, autopsy  
 Belle, D A E, in 1920 male, 8 years old Operative procedure, autopsy

Table I gives a list and brief resume of sixty-three cases of volvulus of a sigmoid megacolon collected from the literature, including the author's case, which came to operation. It also includes eight cases in which the volvulus was discovered at autopsy and in which operation was not done. As complete an analysis as was possible has been made from the material submitted by the various authors on the operated cases.

TABLE II

Sex	Age	
Males	42	- 10
Females	21	11- 20
Not reported	1	21- 30
	—	31- 40
	64	41- 50
		51- 60
		61- 70
		71- 80
		81- 90
		91-100
		Not reported
		3
		64

\* Immediate resection of the volvulus

*Sex*—This condition was twice as common in males as in females. In true Hirschsprung's disease the ratio of men to women is 3 to 2.

*Age*—There are several points of interest here. Twenty-eight or 46 per cent of the patients are from forty to sixty years of age, while only 8 or 13 per cent are under twenty years of age. Mummery in 100 collected cases of megacolon found 30 per cent under twenty and only 13 per cent from forty to sixty. This condition of volvulus then appears to occur more frequently in persons past middle life and not so often in children and young people while exactly the reverse is true in the uncomplicated Hirschsprung's disease.

TABLE III—Number of cases, 64 constipation, 42 pain, 43, vomiting, 20 (2 fecal), previous attacks, 31, distension 48 visible peristalsis, 16, mass, 6, positive X-Ray, 3

*Symptoms*—Forty-two or 65 per cent gave a definite history of constipation, fourteen of these from birth, five from childhood and the rest from two to twenty years.

Periods of obstipation usually associated with the acute attack, were noted by thirty-nine patients. The average duration was four and one-half days, the longest eighteen days. In Hirschsprung's disease it is well known that patients may go many weeks to months without a bowel movement.

Abdominal pain was noted in forty-three cases. Apparently there was nothing characteristic about this pain.

Vomiting was present in twenty, there were two that had fecal vomiting, one recovered and one died.

*Previous Attacks*—Thirty-one gave a history of one or more previous similar attacks. Bloodgood's patient had thirty-two attacks before the final operation.

Visible peristalsis was present in but sixteen cases and an abdominal mass was felt in six.

In three patients a diagnosis of volvulus was made by means of X-ray.

TABLE IV—*Previous Operations*—Number of cases, 15, detorsion, 11, detorsion and colostomy, 5, detorsion and ileostomy, 2, detorsion and appendicostomy, 1, detorsion and colocolostomy, 2, detorsion and ileo-rectostomy, 1, detorsion and fixation, 1, abdominal puncture, 1.

Fifteen patients had twenty-three previous operations for relief of the volvulus, the commonest being simple detorsion. The only attempt to prevent further return of the volvulus was fixation of the sigmoid loop to the parietal peritoneum in one case. Puncture of the abdominal wall with a trocar was done in one case, necessitating immediate exploration for suture of the punctured sigmoid volvulus. This was followed by death due to peritonitis.

*Type of Volvulus*—(Table I)—In thirty-one cases the volvulus was described, thirteen were 180 or one-half of a turn, two were 90 or two and one-half turns, and the remainder varied between 90 and 900. Fifteen were twisted clock-wise and six counter-clockwise.



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TABLE V—*Complications*—Gangrene of involved loop, 8 cases, 5 deaths, peritonitis, 5 cases 2 deaths, perforation of bowel, 1 case, 1 death, vessels of mesosigmoid (thrombosed), 3 cases, 2 deaths

TABLE VI—Number of cases described as megacolon, 64, hypertrophy of all coats mentioned in 18 cases, length of megacolon mentioned in 24 cases, average, 76 centimetres, measurement of normal sigmoid, 40 centimetres, circumference mentioned in 11 cases, average, 35 centimetres, measurement of normal sigmoid, 12 centimetres, diameter mentioned in 15 cases, average, 12 centimetres, measurement of normal sigmoid, 4 centimetres, thickness of wall mentioned in 4 cases, average, 8.7 millimetres, measurement of normal sigmoid, 5 millimetres

In all of the sixty-four cases the chief finding appeared to be the large size of the sigmoid loop. Unfortunately, exact measurements were not given in twenty-eight cases. In these the authors emphasized the large size of the megacolon by various comparisons, with the large intestine of the horse, the thigh or hip of an adult, *etc*

TABLE VII—Dilatation of other portions of the colon, 7, entire large bowel (Hirschsprung's disease), 2, transverse and descending, 2, distal half of transverse and descending, 1, descending, 1, mentioned but not designated, 1. Total, 7

It is interesting to note that only a little over 1 per cent of these cases shows involvement of any portion of the remainder of the large bowel and in but two was there evidence of dilatation of the entire large intestine

TABLE VIII—*Operative procedure, resection*, Mickulicz, three stage, 18 cases, 2 deaths, resection, end-to-end anastomosis, 15 cases, 4 deaths, resection, side-to-side anastomosis, 6 cases, Mickulicz with immediate resection, 3 cases, 2 deaths, resection, type not mentioned, 2 cases, 2 deaths, detorsion, 5 cases, 3 deaths, detorsion and fixation, 5 cases, detorsion and colocolostomy, 2 cases, detorsion and ileo-sigmoidostomy, 1 case, detorsion and colostomy, 4 cases, 2 deaths. 61 cases, 15 deaths

Results not known in two cases. Mortality—24.5 per cent. From the above figures and with the experience of the author's case the Mickulicz type of resection in three stages would seem to be the safest procedure.

Whether this condition is congenital or acquired seems difficult to determine. In no one of the sixty-four cases was there any mention made of an obstruction which might have been the cause of the megacolon. There have been many theories put forward as to the possible etiology of this disease and one is that a chronic volvulus due to the long mesosigmoid may eventually cause hypertrophy. But as Mummery says, "Even when such a condition as a chronic volvulus exists this may be a secondary consequence of the dilatation, and not its cause." In his 100 collected cases of this disease he found evidence of obstruction in only twenty-three. In this connection he says, "The fact remains that in the great majority of cases no obstruction of any kind is found and also that in several the dilatation extended right down to the anus or middle of the rectum." That acquired megacolon is a possibility is shown in a recent article by Shelley in which it was possible to follow the development of dilatation of the large bowel subsequent to a stricture of the rectum.

## SIGMOID MEGACOLON VOLVULUS

Whether the disease described in this paper and the so-called idiopathic dilatation of the colon are one and the same we do not know. Recent work by Wade and Royle and by Judd and Adson in connection with lumbar sympathetic ganglionectomy seem to point to a neurogenic origin of the disease in certain of the cases. They believe that the motor impulses to the longitudinal muscle of the rectum are supplied by the parasympathetics, and the motor impulses to the circular muscles of the rectum are supplied by the sympathetics and that the improvement obtained in this disease following ganglionectomy is due to the reduction of the sympathetic stimuli coming from the lumbar rami communicantes through the hypogastric and pelvic plexuses. It will be interesting to follow the course of the patient described in this paper to see whether further enlargement of the remaining large bowel will take place in the future.

### CONCLUSIONS

(1) That there is a very definite clinical entity known as volvulus of a megacolon of the sigmoid.

(2) That the dilatation in this condition is usually limited to the sigmoid in the majority of cases.

(3) That this condition unlike uncomplicated Hirschsprung's disease, occurs in middle age.

(4) That to prevent further recurrence the involved loop should be resected preferably by the Mickulicz procedure.

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# DIVERTICULUM OF THE MALE URINARY BLADDER

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THE initial cause of sacculated or diverticulated bladders is, perhaps with some few exceptions, congenital, traceable to some embryologic disparity, a disparity so likely to be compromised by any degree of deformity from a mere sacculation to the most pronounced exstrophy—even hypospadia and anaspidias—that the resulting problems have on many occasions, tried and baffled the judgment of the most adroit of genito-urinary surgeons.

Obstruction, whether partial or complete, has by many observers, been regarded as an important etiologic factor yet, and while it must be admitted that such an obstruction to the bladder's outlet is a cause in the bringing forth of this deformity, it must not be forgotten that it is merely a relative one. Nor should it prevent the fullest inquiry when it must be ever in mind that the question of a ratio is ever present—the ratio that correlates that great number of occluded urethrae where diverticula or saccule do not obtain, and the much smaller number where they do. Here, may the question of "why?" be interjected. Why are saccule and diverticula the exception then, instead of the rule when this comparison is made to parallel these two sets of reckonings?

There are those of our genito-urinary surgeons who, having felt the truth of this, concluded that urethral obstructions, whether of prostatic or cicatricial origin, are mere factors. Never a cause.

The normal bladder may be distended to a remarkable degree without entailing the slightest risk of provoking either saccules or diverticula. Let it be put in this way, namely: The actual cause of sacculation or diverticulation within the wall of the male urinary bladder is congenital but is impotent unless urethral obstruction, partial or complete, distention and compression be present as contributing factors.

To determine how much of the truth might be coupled with the foregoing supposition, a number of bladders, secured from slaughtered pigs, were subjected to the following rather crude tests. When extreme distention was induced by either water or air, the mucosa, at no point, showed a tendency to herniate. Nor did it when severe compression was subsequently applied. But when a portion of the bladder's wall had been gently teased away from its underlying mucous lining, and the maneuver repeated, no sign of pouting appeared until the compression was applied, and then, and almost immediately, the mucosa began to bulge through the denuded area, and a diverticulum, in the making, was emphatically demonstrated.

There are those among our physiologists who teach that the normal act of urinating depends more on compression from the intestines than it does on the

contractility of the bladder's muscular coat. If this is true, the fact that the bladder has a muscular coat, moots the question. However, that cannot be discussed here. But whatever the truth of it may be, compression, up to some unknown degree, seems to be the determining factor in forcing the mucous membrane to herniate into an extravascular sac. It must not, however, be forgotten that unless ectopia of the muscular fasciculi be present, neither the obstruction, distention nor compression can give rise to the deformity.

To elucidate the primary or congenital cause of these diverticula, it will



FIG. 1.—(a) Small sacculations the fasciculi are not displaced to a degree capable of pouting the bladder's mucosa into a diverticulum. (b) Large sacculations. Here are the openings that lead to a sac only. Diverticulitis is not to be expected where so many large sacculations are present. It may occur but the fasciculi are usually discouragingly arranged. (c) Typical opening into diverticulum. Note the fibrous ring. (d) Section of diverticulum.

be necessary to briefly review the embryologic development of the genito-urinary tract. In doing this, we will find something to puzzle over when through speculative curiosity, we would like to find out the time that the kidneys begin the first secretion of urine.

Of course, this question is irrelative. Perhaps it should have been omitted, yet it is an emphasis on that which is of paramount interest, for it becomes apparent that unless the allantois had opened into the ventral cloaca in time to save itself from becoming distended by the urine from the newly functioning

kidneys a disparity of that portion of its structure, destined to be the muscular coat of the developing bladder, would result in a chaotic dispersion of the subsequently developed muscular fasciculi, and thus force into the bladder wall areas of potential diverticula. If the allantois is granted its communication with the ventral cloaca before the distention has caused an irreparable condition, no more than an illy marked trabeculation may be the ultimate result. Otherwise, should some embryologic irregularity prevent a timely communication, and the distention finally end in rupture, an exstrophy would be the likely result. Between these two extremes, may be conjectured the various congenital bladders with which we have to deal, and in which is to be found the reasons why the best of us are often at our wits' end, for we are dealing with defects that are not always amenable to good surgery because of the flabbiness of the tissues with which the repair has to be made, a flabbiness that had its origin in or during the embryologic distention. Pouching of the bladder wall is a condition that in no way should have its etiology confused with that of the diverticula or sacculations. Pouching may come to any normally developed bladder through the presence of a calculus, the removal of which, followed by proper drainage, is all that is required to restore the pouched portion of the bladder's wall to its normal contour.

Experience has given us a fear of sodium bromide when used as a diagnostic adjunct to roentgenology. It was the only medium used through which we had two severely fatal burns. I know of no statistics on this particular point but having had no such sequela following the use of the milder salts of silver, we had given up the bromide salt entirely. When possible, the cystoscope is the diagnostic instrument of choice rather than the X-ray.

What has been outlined in the foregoing is meant as a mere sketch of the conditions through which all surgical approach has to be made. In a word it gives to us the key to the greatest success attainable, for it emphasizes the importance of restoring to the urethra the fullest patency, even to the removal of the prostate when its urethral tunnel is found to be narrowed and this without regard to the size of the gland itself.

Immediate surgery in all these cases is, as a rule, contraindicated. Suprapubic drainage must be the prerequisite of all that is hoped to be accomplished. It also gives immediate relief to the distressing tenesmus-vesicæ. While this drainage is going on, the urethra may be sounded and rendered patent. If its prostatic portion is found to be menacingly narrow, prostatectomy is to be postponed until the bladder has been suprapubically opened for the removal of the diverticulum. Not a few methods of coping, surgically, with bladder diverticula have been described. It probably matters but little what method may be the one of choice so long as good results are obtained, but the method that calls for the sac's inversion, in our experience, proved too cumbersome. It also sacrifices tissues that will be greatly needed in obliterating the space that the sac had previously occupied. Stuffing the diverticulum with gauze lacks surgical appeal because of the danger of tearing the bladder wall while delivering the sac. The opening into these sacs is encircled with a fibrous

ring This ring must be removed else union will be thwarted The incision should be an elliptical one, its long axes directed to the securing of the best working facilities It includes the entire fibrous ring with the mouth and end of the sac With this accomplished, the freed portion is grasped with light forceps and gentle traction is continued into the bladder while a gauze-capped finger gently pushes back whatever tissue may be adherent If the opening thus made in the wall of the bladder is large enough to admit a finger without the likelihood of tearing, the fibrous ring may be severed by a snip

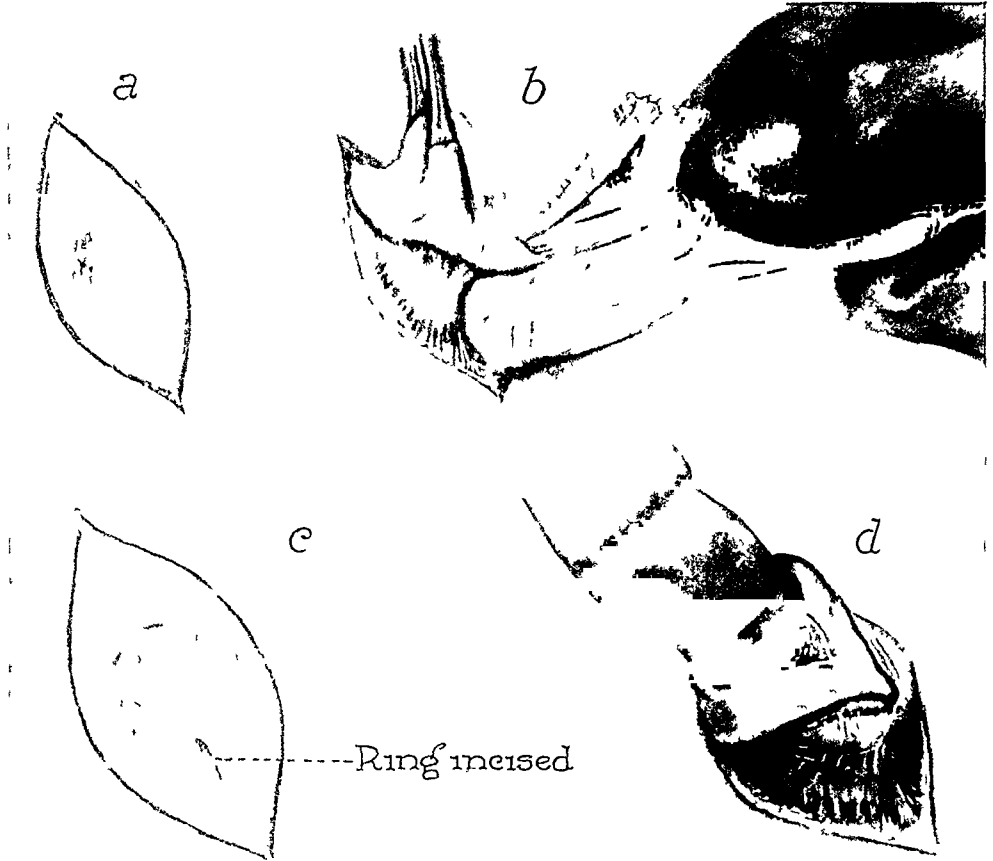


FIG. 2—(a) Elliptical incision preliminary to dissection of the diverticulum (b) Ellipse with opening into sac being drawn into bladder while a gauze capped finger pushes back all adhering tissue (c) Ring incised to admit finger (d) Once the sac is made free a finger within facilitates the dissecting

of the scissors and the further dissecting of the sac facilitated by inserting a finger within it Throughout the time it may require to complete the removal of the sac and the subsequent closure of the opening, sopping with sponges will take care of the urine that is coming in from the ureters

The ease with which the water-shed closure of the opening may be effected will, of course, depend very much upon what portion of the bladder wall is involved If high, and easily reached from the suprapubic incision, little difficulty need be expected When, however, it is low, and the diverticulum

## DIVERTICULUM URINARY BLADDER

has been in a posterior position, the closure should be effected from within the bladder, for extensive separation from surrounding tissues is liable to invite sloughing. The method we have followed is not difficult, yet, it may, at the first try seem so. Number 00 chromic gut is the ideal suture material but it should be softened and rendered pliable in warm water, and by gauze-friction before using. Otherwise it will be too harsh. For the suturing, a small full-curved non-cutting intestinal needle is ideal. The stitch may be begun at either angle of the ellipse according to the convenience of the operator. Inverting the edges of the wound, the needle is made to pick up right side first, two or more bites of the inverted edge, working the needle away from the free edge while doing so. It is then passed across to the left side of the incision and the maneuver repeated with the exception

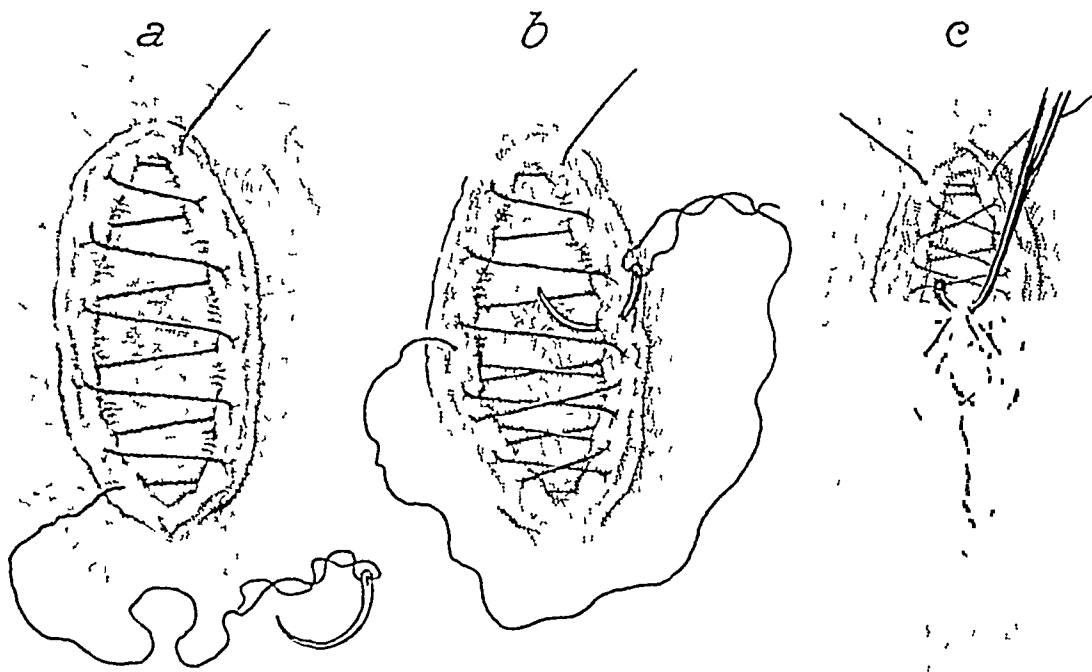


FIG. 3.—a b and c shows technique of a modification of Murphy's (the late John B.) water shed suture. This stitch closes the bladder wound without appearing within the viscus. This avoids leaving any foreign substance to precipitate crystallization of the urinary salts.

that on this side the needle is made to work toward the free edge. The suture from this point on is zigzagged toward the opposite angle which, when reached is given a horizontal direction as in the first application, then zigzagging back, crossing the others to make a series of X's, similar to the lacing of a shoe, until the place of beginning has been reached. The two free ends of the suture are permitted to protrude from between the edges of the wound while a pterygium hook draws the lacing taut. Finally, traction on the ends will approximate the edges in to an appositional or water-shed welt.

The suture may then be tied, the ends cut, and the knot induced between the edges and forced into an extravescical position.



# EXTIRPATION OF PREGNANT UTERUS AT FULL TERM \*

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ABOUT March 1, 1928, Dr M A Tarumianz, of the Delaware State Hospital for the Insane, at Farnhurst, referred to me a Negress, aged thirty-three years, the subject of general paresis. She was the mother of six children, only two living and both mentally deficient, she was at that time within ten days of term with another pregnancy, her Wassermann was four plus, there was a profuse cervical discharge which showed numerous gonococci. To further complicate the situation, the foetal breech was lying in the right iliac fossa. The indications called for (1) Avoidance of the spread of gonorrhœal infection, (2) sterilization of the mother, and (3) delivery of the foetus. To accomplish these triple ends I decided to remove the entire uterus before rupture of the membranes.

On March 15, 1928, the abdomen was incised in the lower mid-line, the broad ligaments clamped on each side and incised down to the level of the cervix. Two clamps sufficiently long to reach across the entire cervical bridge, were thrown into place and the uterus delivered from the abdomen. The cervix was severed with a single cut between the two clamps, the uterus, with its contents, was passed to an assistant, Doctor Pawlikowski, who extracted a living foetus weighing seven pounds, two ounces. The time consumed from start of abdominal incision to delivery of child was less than four minutes.

The cervical stump was cauterized and turned in with a running suture, the stumps of the round and infundibulo-pelvic ligaments ligated, brought down and sutured to it. A fold of the utero-vesical peritoneum was then brought over all to complete the peritoneal toilet. One cigarette drain was placed in the cul-de-sac and the abdomen closed in three layers.

This woman made an uneventful surgical recovery.

Since that time I have met with five other cases in which it was felt wise to adopt a similar line of procedure. Two were cases in whom one or more previous Cæsarean sections had previously been made in whom numerous pelvic and abdominal adhesions were doubtless present, one a case of marked hyperthyroidism with uterine fibroids, another a woman exsanguinated by hæmorrhage due to placenta previa, in which case a minimum of blood loss at delivery was felt essential to give her any chance, which she might possibly have, of recovery.

These cases were operated upon respectively on July 19, 1930, December 20, 1930, January 12, 1931, February 18, 1931, April 3, 1931. All six babies were delivered alive, five mothers made uneventful recoveries and left the hospital in good condition. One mother (Case II) developed a vesico-abdominal fistula on the ninth day, which was closed at a subsequent operation.

In Case IV violent uterine contractions began as soon as an attempt to deliver the uterus from the abdomen was made, and the membranes ruptured just as this was accomplished, so, after the "waters" had drained away, a

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\* Read before the Kent County Medical Society, Dover, Delaware, April 1, 1931

## EXTIRPATION OF PREGNANT UTERUS

clamp was placed across the cervix, the latter incised above it, and the foetus delivered before entire extirpation of the uterus

When conservation of the tubes and ovaries is desired, the operation is more difficult, as the uterine extremities of the broad ligaments are pulled upward by the enlarged organ and offer a much wider pedicle to be clamped and ligated

The use of this operation is suggested for those cases where classical Cesarean section would be followed by hysterectomy (the Porro operation and its modifications)

(1) Where it is of primary and vital importance to avoid contamination of the abdomen

(2) Where it is deemed best to avoid subsequent pregnancies in the patient

(3) Where extirpation of the uterus would be otherwise indicated as in co-existing fibroid tumors (Case IV)

(4) Where it is imperative to obviate all possible blood loss

The operation is not indicated where it is desired and feasible to continue the reproductive function of the woman

The average time of the operation has been shorter than the average time of classical Cesarean section, the "shock" less, or certainly no greater, and a less complicated convalescence is usual

This method is offered, *not as a substitute for other methods of Cesarean section* (save the Porro operation), but as a contribution to the armamentarium of the obstetrician to be held in reserve until the emergency to which it is applicable arises

### ABSTRACT OF CASES

CASE I—Chester, Pa Age, thirty-three years, Para VII Referred by Dr M A Trummel

Term pregnancy Oblique position of foetus Lues Gonorrhoeal cervicitis General paresis

*Operation*—March 15, 1928 *Anæsthesia*—Ether

*Infant*—Male, condition good, weight 7 pounds, 2 ounces N B—Turned over to Children's Bureau on March 17, 1928, apparently in good condition

*Surgical Convalescence*—Uncomplicated

CASE II—Penn's Grove, N J Age, twenty-one years, Para III Referred by Dr R B Jarrett

Pregnancy at thirty-sixth week Two previous Cesarean sections (1926 and 1928) Weakening uterine cicatrix Pelvic adhesions

*Operation*—July 19, 1930 *Anæsthesia*—Gas-ether

*Infant*—Female, fair condition upon delivery, weight 6 pounds, 2 ounces N B—This infant died nine hours after delivery *Autopsy*—Interstitial pneumonia, hyperplastic thymus, cloudy swelling of the kidneys

*Surgical Convalescence*—Complicated by development of an abdomino-vesical fistula on the eighth day Apparent spontaneous closure after ten days' use of a self-retaining catheter Mother discharged in good condition on August 16, 1930 Returned to hospital August 26, 1930, after reopening of fistula Surgical closure under gas anæsthesia on August 27, 1930 Final discharge on September 13, 1930, in good condition

CASE III—Millington, Md Age, twenty-seven years, Para V Referred by Doctor Brice

Pregnancy at thirtieth week Free uterine hæmorrhage Full placenta previa

Operation—December 20, 1930 Anæsthesia—Gas (only)

Infant—Male, living but premature, weight not recorded N B—This infant died in sixty-two hours Autopsy—Patent foramen ovale Prematurity

Surgical Convalescence—Uncomplicated Mother discharged in good condition on January 4, 1931—fifteenth day

CASE IV—Wilmington, Del Age, thirty-five years, Para I Referred by Dr B J McEntee

Hyperthyroidism Uterine fibroids Term pregnancy

Operation—January 8, 1931 Anæsthesia—Gas (only)

Infant—Female, condition good, weight 6 pounds, 12½ ounces

Surgical Convalescence—Uncomplicated Discharged in good condition on sixteenth day

CASE V—New Castle, Del Age, twenty-nine years, Para II Referred by Dr Lewis Booker

Term pregnancy Contracted pelvis Previous Cesarean section Pelvic adhesions

Operation—February 18, 1931 Anæsthesia—Spinal

Infant—Female, condition good, weight 8 pounds, 8 ounces

Surgical Convalescence—Uncomplicated Discharged on seventeenth day in good condition

CASE VI—Wilmington, Del Age, twenty-nine years, Para III Referred by Dr Fred Armstrong

Term pregnancy Contracted pelvis Two previous Cesareans

Operation—April 3, 1931 Anæsthesia—Spinal

Infant—Female, condition good, weight 6 pounds, 1½ ounces

Surgical Convalescence—Uncomplicated Discharged on fourteenth day in good condition

*Comments*—At the time the first operation was performed no thought of attempting a new procedure was entertained It was approached entirely with the idea of working out what was best for the particular case However, as other cases were brought to us to which the same principles could be advantageously applied, variations were tried and discarded or adopted, oftener the former

In Case I Doctor Tarumanz desired the removal of the ovaries for psychiatric reasons, so the infundibulo-pelvic, round and broad ligaments were clamped and cut distal to the tubes and ovaries In the same case only so much of the utero-vesical peritoneum was reflected as would serve as a flap for the cervical stump

In subsequent cases it was found that the former was easier than where it was desired to conserve the ovaries and tubes, but, on the other hand, that the reflection of the utero-vesical peritoneum and bladder not only gave a neater result but otherwise expedited the operation

In Case IV delivery of the uterus from the abdomen was done before reflection of the utero-vesical peritoneum and severing of the broad ligaments This was found a distinct handicap rather than an advantage

The use of gauze sponges, or pads, was discarded until after delivery of

## EXTIRPATION OF PREGNANT UTERUS

the uterus as they are not needed and interfere with motility of the intra-peritoneal structures

Adhesions which may exist from previous operations or other causes, should be carefully and completely freed as the first step after entering the abdomen

The results of our work so far, have led to the adoption of the steps as outlined below, and in the order given

- (1) Incision of abdomen
- (2) Freeing of adhesions, if existent
- (3) Reflection of the utero-vesical peritoneum and bladder
- (4) Application of clamps to broad ligaments
- (5) Severing of broad ligaments
- (6) Delivery of uterus from abdomen
- (7) Application of clamps to cervix
- (8) Severing of cervix
- (9) Passage of uterus and contents to assistant (who immediately extracts infant)
- (10) Ligation of broad ligaments
- (11) Suture of cervical stump
- (12) Suture of pedicles to cervical stump
- (13) Suture of utero-vesical peritoneum over "raw" area
- (14) Drainage of cul-de-sac, at discretion of operator
- (15) Closure of abdominal incision

## INTERPARIETAL HERNIAS

BY WILLIAM E. LOWER, M.D., AND N. FRED HICKEN, M.D.

OF CLEVELAND, OHIO

FROM THE CLEVELAND CLINIC

THE term "interparietal hernia" is used collectively to designate a group of rather unusual hernias which are located in the inguinal region between the various layers of the abdominal parietes. Anatomically, these hernias may be classified as follows: (1) Properitoneal hernia, that type in which the hernial sac lies between the peritoneum and the transversalis fascia, (2) interstitial hernia, in which the sac lies between the transversalis fascia and the transversalis, internal oblique, or external oblique muscles, and (3) superficial hernia, in which the sac is situated between the aponeurosis of the external oblique muscle and the integument.

Since interparietal hernia has been spoken of by all authorities as being of rare occurrence it is surprising to find that 587 cases have been reported in the literature. The inability to diagnose this condition pre-operatively and the consequent high mortality rate indicate how superficial is our knowledge of this type of hernia. Since the days of Thomas Bartholin (1661), many noted surgeons have been chagrined because they failed to recognize this type of hernia at the operating table, the mistake being revealed at recroscopy.

Because of these considerations, we feel justified in presenting a clinical study of interparietal hernias based on cases observed at the Cleveland Clinic and those reported in the literature.

### TWO CASES OF INTERSTITIAL HERNIA

CASE I.—The patient, a truck driver, aged fifty-eight, reported at the Cleveland Clinic April 27, 1929, complaining of pain occurring low in the left side.

Four years previously, a severe pain suddenly developed in the lower left abdominal quadrant radiating downward toward the bladder and penis. The paroxysm lasted about thirty minutes and then subsided, leaving him perfectly well. There had been no nocturia, frequency, burning on urination, urgency, nor hematuria, and the urine had never contained any gravel.

Three months later a similar attack occurred, and since then the attacks had progressively increased in frequency and severity. Most of the paroxysms were initiated by work, exercise, lifting, or straining, and were always associated with the act of defecation. When the patient lay down, the pain immediately disappeared, often recurring, however, as soon as he stood up. He had never observed any swelling in the groin, and emphatically denied being "ruptured." Both testicles had always been in the scrotum. The day before his admission to the clinic he had an attack of severe pain in the left groin and felt nauseated but did not vomit. The pain was intense while he was working, but subsided when he assumed a recumbent position. Some soreness was present in the region of the left groin.

The general physical examination showed a well-nourished adult male. The temperature was 97.6°, the pulse rate 64, and the blood-pressure 135/100. The pupillary

## INTERPARIETAL HERNIAS

reactions were normal, the teeth were in good condition, the tonsils atrophic, and the heart and lungs were normal. The abdomen was symmetrical, slightly distended, and presented the appearance of generalized rigidity. The patient complained of slight tenderness in the left groin above Poupart's ligament near the internal inguinal ring, and when pressure was applied at this point the patient felt a sense of soreness and said that he could feel "something slipping back into the abdomen." No masses or swellings could be detected. Both external rings were slightly dilated, but no hernial sac could be felt, and no impulse was transmitted during the act of coughing. Cystoscopic and pyelographic studies showed that the genito-urinary tract was normal, and all laboratory studies gave normal values. Gastro-intestinal roentgenograms failed to indicate any point of intestinal obstruction.

We felt that we were dealing with a case of partial intestinal obstruction produced by some mechanical constriction in the region of the internal inguinal ring. We were convinced, however, that the cause was not a common direct or indirect inguinal hernia. As conservative treatment did not result in improvement, operative intervention was deemed necessary.

An oblique incision was made in the lower left quadrant a half-inch above and parallel to Poupart's ligament. The aponeurosis of the external oblique muscle was exposed, but no inguinal hernia was palpable. On palpation in the region of the internal inguinal ring, a "gurgling sensation" could be felt, and it seemed as if a "loop of bowel" suddenly receded into the abdomen. The external oblique muscle was incised just mesial to the course of the inguinal canal, and a small empty hernial sac was found between the external and internal oblique muscles. By careful dissection the sac was isolated and it was found to have passed through the internal and external oblique and transversalis muscles, piercing the transversalis fascia, and opening into the peritoneal cavity about 1 centimeter to the left and just above the internal inguinal ring. There was no communication with the inguinal canal. The spermatic cord and vessels could be seen entering the inguinal canal through the internal ring, and no inguinal hernia was demonstrable. The orifice of the hernial sac readily admitted the thumb, and the neck was thick and elastic but easily dilatable. The belief seemed reasonable that any increased intra-abdominal pressure would dilate the neck of the sac and permit the intestines to enter. No incarceration, however, had taken place. The neck of the sac was securely ligated, the various layers of the abdominal wall were closed, and the patient made an uneventful recovery.

CASE II—The patient, a woman, aged forty-one, the mother of three children, reported at the Cleveland Clinic on May 13, 1930, complaining of abdominal pain.

For the past six years she had suffered from flatulence, abdominal distention, and pains in the upper right quadrant. On two occasions there had been "chills and fever," associated with some tenderness over the region of the gall-bladder. Five years before this examination cholecystostomy had been performed, and a few stones and much pus had been found. Since then abdominal pain and tenderness had recurred in the old scar. During the three months previous to her entering the Clinic, pain had been present in the right inguinal region which was accentuated by working or by lifting heavy objects. At times the patient thought she could feel a slight swelling in the groin, but when questioned, she admitted that it was only her "imagination." At times the distress became so intense that she would be compelled to lie down, and immediately she would feel a peculiar "sliding sensation" in the right groin, and the pain would disappear. She denied having been ruptured.

Examination revealed a well-developed adult female. The temperature was 99.2°, the pulse rate 92, and the blood-pressure 148/94. The pupils were equal, with normal reactions. The heart and lungs were essentially normal. A scar in the upper right rectus muscle was indurated, tender, and inflamed. There was some localized muscular

rigidity but no feeling of fluctuation. The gall-bladder could not be palpated on account of the tenderness in this region. In the right groin, just above the external inguinal ring, was a small swelling which increased in size on straining and to which a definite impulse was imparted by coughing. The external ring was small, and no enterocele could be palpated in the canal. Both femoral rings and the left external inguinal ring were normal.

The pre-operative impression was that an abscess of the gall-bladder was pointing in the old cholecystostomy scar, and that an interstitial hernia was present in the right inguinal region. The latter diagnosis was made because of our experience with the previous case.

A transverse incision was made over the right inguinal canal. A probe was readily introduced into the canal through the external ring, and no enterocele or obstruction was encountered. On palpation, a small tumor-like mass could be felt just near the outer side of the canal. An incision was made directly over the swelling, and as soon as the fibres of the external oblique muscle were separated, a small, partially collapsed hernial sac was seen lying between the two oblique muscles. When this sac was opened, a few tags of omentum were disclosed. The sac was carefully dissected free from the adjacent structures, to which it was fairly adherent. It lay in direct apposition to the lateral walls of the inguinal canal, pierced the internal oblique and transversalis muscles, as well as the transversalis fascia, and opened into the peritoneal cavity by its individual orifice, situated just lateral to and above the internal inguinal ring. The round ligament entered the inguinal canal through a normally located inguinal ring, and there was no communication between this canal and the interstitial hernia. The sac was ligated, the aperture through the abdominal wall was closed, and the patient made an uneventful recovery.

In both of the cases described above the condition was caused by a simple interstitial hernia, the sac in each instance being contiguous to but not communicating with the inguinal canal, each having its own separate orifice. Kronlein has discussed this type of hernia to which, because of its juxtaposition to the inguinal canal, he gave the name "para-inguinal interstitial hernia."

As there are three anatomical varieties of interparietal hernia—properitoneal, interstitial and superficial hernias, these will be discussed separately.

#### PROPERITONEAL HERNIA

The first authentic report on interparietal hernias was made by Bartholin in 1661, but his description was not sufficiently complete to permit classification. In 1779 Petit described a group of hernias which were situated within the interstices of the abdominal wall. In 1839 Parise saw a hernia in which the sac was situated between the peritoneum and the transversalis fascia, and in 1851 he described it under the name of "intra-iliac hernia." In 1864 Streubel collected reports of fourteen cases. The most important work however was done by Kronlein, a report of which was published in 1876. He collected and analyzed twenty-three cases which had been reported up to that time, he carefully described the anatomical positions and clarified the etiologic factors concerned in their production, giving to this type of hernia the name "hernia inguinoproperitonealis." In 1895 Breiter, a pupil of Kronlein, collected thirty-six additional cases, and in 1900 Gobell brought the literature up to date, presenting a series of sixty-nine cases. Since that time

we have been able to gather reports of fifty cases from foreign and English journals, making a grand total of 119 cases of properitoneal hernia thus far reported

*Definition and Anatomical Considerations*—Since properitoneal hernia usually occurs in the form of a diverticulum from the walls of an inguinal or femoral hernia, cases of this type are generally designated inguinopropertoneal or cruriopropertoneal hernias. Moynihan reserves the name "properitoneal hernia" for those which fulfill the following conditions: (1) The hernial sac must be bilocular, one loculus extending down into the inguinal or femoral canal, and the other spreading out between the peritoneum and the transversalis fascia. (2) The two loculi must communicate with each other. (3) Both loculi must open into the peritoneal cavity by means of a common orifice—either the internal inguinal or the femoral ring.

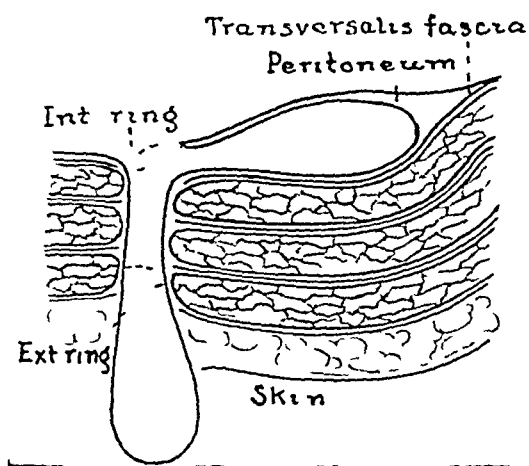


FIG 1—Bilocular properitoneal hernia

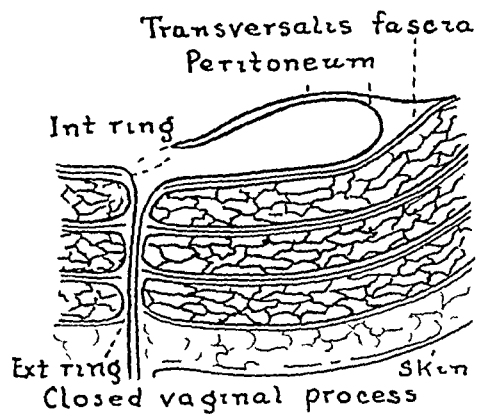


FIG 2—Monolocular properitoneal hernia

Moynihan, Halstead, and many other authorities agree that all properitoneal hernias are bilocular, as shown in Fig 1. However, we have been able to collect fourteen authentic cases in which only one sac could be demonstrated, as illustrated in Fig 2. At operation, the enterocele was found to have entered the inguinal canal through a normal internal inguinal ring, but instead of extending down the inguinal canal, the hernial sac had spread out between the fibres of the peritoneum and transversalis fascia. The process vaginalis which continued down into the scrotum or into the labia was completely closed, and no hernia was present. These, therefore, were typical monolocular hernias. Gobell found that of sixty-nine cases of properitoneal hernia sixty were bilocular and nine were monolocular. Novaro, who in 1921 made a careful study of this type of hernia, is convinced that monolocular forms do exist.

Halstead maintains that a properitoneal hernia always occurs as a diverticulum or outpouching from a preexisting inguinal or femoral hernia. However, the following cases suggest that a properitoneal hernia can occur as a distinct and separate entity, without having any communication with the inguinal or femoral canals. Wagner, Brunner, and Englisch each report a



case of an inguinal hernia and a coexisting properitoneal hernia. These hernias were separate and distinct, each opening into the abdominal cavity through an individual orifice. In 1902, Howlett reported a case of a bilocular properitoneal hernia in which both loculi were situated between the peritoneum and transversalis fascia, one sac extending upward and outward and the other downward and inward. At the first operation only one sac was recognized, but as the symptoms of nausea and vomiting persisted, a second operation was performed which revealed a loop of strangulated bowel in the second properitoneal sac. This is a good example of a properitoneal hernia occurring outside of the inguinal canal but lying adjacent to it.

It would seem, therefore, that properitoneal hernia, in both the monocular and the bilocular forms, may be classified as follows: (1) Inguinoproperitoneal hernia, which occurs as a diverticulum from a preexisting inguinal hernia. (2) Cruroproperitoneal hernia, which occurs as an outpouching of a femoral hernia. (3) Simple properitoneal hernia which is independent of the inguinal or femoral canals.

The anatomical positions which may be assumed by the properitoneal sac must be clearly understood if these hernias are to be treated surgically. Usually it occupies one of three positions: (1) It may pass upward and outward toward the anterosuperior iliac spine. This is the usual position. (2) It may pass directly backward, and occupy the iliac fossa. This form is often mistaken for a retroperitoneal hernia, and its relation to the inguinal canal is forgotten. (3) It may pass downward and inward to the side of or in front of the bladder. This type has been called the inguinovesical or prevesical hernia.

*Etiology*—Precise knowledge concerning the formation of properitoneal hernia is wanting, as is attested by the number of theories which have been advanced, of which only a few of the most logical can be discussed.

After making a meticulous study of the inguinal canal, Eppinger decided that its anatomical structure was such that it predisposed to the formation of properitoneal hernia. He arbitrarily divided the canal into three portions: (1) The innermost section, which extends from the internal inguinal ring to the point where the infundibuliform fascia pierces the transversalis muscle. In this portion of the canal the transversalis fascia is firmly adherent to the transversalis muscle, but only a few fibrous tissues connect it with the peritoneum, this space being filled with loose, non-resisting fatty tissue. (2) The middle portion of the canal, which is 10 to 12 centimetres long, and is surrounded by the internal oblique and transversalis muscles. Here the muscular reinforcement precludes the formation of interparietal hernias. (3) The anterior segment of the canal, which corresponds to the space between the internal oblique muscle and the external inguinal ring. The two oblique muscles are loosely attached to each other by strands of connective tissue, and the interstices are filled with loose, yielding, adipose tissue. It is thus evident that the weakest points in the inguinal canal are

at the inner and anterior segments, and it is here that interparietal hernias are encountered clinically

It has been observed that properitoneal hernia frequently is associated with conditions which prevent the normal descent of the hernial sac. Macready, Streubel and Kionlein noticed that an ectopic testicle situated in the inguinal canal or just outside of the external inguinal ring obstructs the descent of a congenital hernia, and if the impulses from above continue, the hernial sac is forced between the layers of the abdominal wall. It must be remembered, however, that properitoneal hernias are found in males with normal testicles, and have been reported also as occurring in women, hence some other factors must operate in their production. Von Mosetig-Moorhof insists that a narrowing of the external inguinal ring permits the bowel to descend into the dilated inguinal canal but prevents its descent through the external ring, and therefore, the hernial sac insinuates itself between the abdominal muscles. In support of this theory, Tillaux describes a case of properitoneal hernia in which the opening of the external ring was so small that it barely permitted the passage of a nerve, much less an enterocele. Butz and Bramann cite a case in which the external ring was entirely absent, yet a properitoneal hernia was found. Moynihan believes that a defective formation of the scrotum results in an ectopic process vaginalis and testes, with resulting obstruction to the descent of a coexisting congenital hernia. Coley encountered a case in which a hydrocele in the canal of Nuck acted as a barrier to the descent of a congenital enterocele and caused a properitoneal hernia. Streubel maintains that an ill-fitting truss which permits the canal to remain open and merely presses over the external ring causes a mechanical obstruction which predisposes to the formation of interparietal hernia. According to Birkett, this theory is untenable, as malposition of a truss is very common and the occurrence of this hernia is infrequent.

It has been suggested that a narrowing of the internal inguinal ring might prevent the replacement of a large hernia into the peritoneal cavity. Gosselin and Streubel pointed out that if the internal inguinal ring was constricted and pressure was exerted from below, as in repeated and indiscriminate taxis, it might cause a bulging of the neck of the sac between the peritoneum and the transversalis fascia. By pressure over a large scrotal enterocele, Corner was able to force the intestines into a properitoneal sac, and by pressure over the properitoneal swelling, the hernial content immediately descended into the scrotum. While doing the hemiorrhaphy, he was able to repeat this phenomenon, and found a narrow internal ring which diverted the scrotal contents into the properitoneal sac. Many of the so-called reductions en masse were merely instances in which the scrotal hernia was forced into a preformed properitoneal sac. The accepted explanation of reduction en masse is that an inguinal or crural sac, by repeated and forcible manipulation, is separated from its surrounding structures, and is invaginated or pushed back into the abdominal cavity without disturbing the mutual rela-

tionship between the sac and its content The reduced hernia always lies outside of the peritoneum

To us it seems that the difficulty encountered in separating a hernial sac from its surrounding structures during herniorrhaphy would preclude dislocation of the hernial sac en masse by simple taxis Streubel and Halstead believe that such cases of reduction en masse are merely the transference of the content of a scrotal or crural sac into a preformed properitoneal sac Moynihan reviewed the specimens of reduction en masse in Guy's Hospital Museum, and concluded that most of them were from cases of properitoneal hernia In studying the reports of cases of reduction en masse, we found that the description of the operative findings was so meager that the true anatomical position of the sacs could not be determined We agree with Halstead and Moynihan, however, that examples of true reduction en masse are rare, and that most of the cases which purport to be of this nature are really cases of properitoneal hernia

In contrast with the theory of the mechanical origin of properitoneal hernia are the arguments of those who believe that all hernias are congenital Rokitsansky pointed out that in many cases small peritoneal pouches or diverticula could be seen in the immediate neighborhood of the internal inguinal ring, these he believes, constitute the anlage of properitoneal hernia Brunner, Englisch, and Wagner also noticed these small peritoneal pouches, and thought them responsible for interparietal hernias In 1884, Wagner confirmed his convictions by finding a case of inguinal hernia with a coexisting properitoneal hernia which lay adjacent to the inguinal canal but did not communicate with it Russell maintains that all hernias are congenital and that the process vaginalis can be caught up between the layers of the abdominal muscles and form any variety of interparietal hernia In a series of 200 post-mortem examinations, Raw and Murray found sixty-eight peritoneal diverticula, fifty-two of them being femoral, thirteen inguinal, and three umbilical Murray believes that when these congenital diverticula or pouches exist, the occurrence of hernia depends on the size of the opening and the strength of the muscles that protect the orifice

Coughlin's anatomical studies of adults and Moynihan's of fetuses revealed that in 22 per cent of necropsies they could clearly demonstrate deep peritoneal pouches or fossæ near the obliterated hypogastric artery which easily could have developed into properitoneal hernias

Kirchner reports a case of such a properitoneal hernia arising in Hesselbach's triangle as the result of a peritoneal diverticulum near the obliterated hypogastric artery How can the occurrence of multiple hernias in the same individual be explained unless the theory of their congenital origin is accepted? Bambridge operated on a woman in whom six separate and distinct hernias were present Congenital malformation of a hernial sac is evident in the bifid or pantaloons hernias of Halstead, in which the inguinal sac is divided into two compartments like a pair of trousers and opens into the abdominal cavity through a normal internal inguinal ring

Schmidt demonstrated that there might be a congenital dislocation of the internal inguinal ring upward and outward. As a result of the displacement, the spermatic cord would be too short to reach the scrotum, and an ectopic testicle would result. He convinced Oberst, Trendelenberg, Zeller, and Link that this theory was correct, but we have been able to collect only three cases which substantiate this view, those of Schmidt, Bramann, and Holder.

It must be self-evident therefore, that the pathogenesis of properitoneal hernia cannot be ascribed to a single cause but rather to a combination of many factors.

*Incidence and Sex*—The incidence of properitoneal hernia is a subject of much controversy. Bull and Coley found but one case out of 5,000 consecutive herniotomies, while Kirchner observed two cases out of 500. We believe that the frequency of properitoneal hernia is greater than these figures indicate and that many cases have remained undiagnosed.

Both sexes are affected, but the condition is much more common in the male than in the female because of the greater percentage of congenital anomalies which are present in the male inguinal region. Of the cases collected since 1900 thirty-three have been reported in males and nine in females and in eight the sex was not mentioned.

All ages are involved, the youngest patient being fifteen and the oldest seventy-five. The average age for the male is thirty-eight, the greatest number of cases occurring between the ages of thirty and fifty years, which is the period of greatest muscular activity. In women the average age is fifty-five.

The right side is involved more frequently than the left, because of the greater percentage of congenital anomalies associated with the later closing of the right vaginal process. In Gobell's series of sixty cases, thirty-seven occurred on the right side and twenty-three on the left. In our collection, twelve were found on the right side and eight on the left, the side not being mentioned in thirty cases.

*Symptoms*—There is no pathognomonic sign or symptom that will lead to the diagnosis of properitoneal hernia. Fully 90 per cent of the patients will present themselves with the clinical syndrome of acute intestinal obstruction. They may have had a reducible inguinal or femoral hernia of long standing. Following an apparent reduction, the patient becomes nauseated and vomits, the abdomen becomes distended, and the bowels constipated. On examination, an irreducible inguinal or femoral hernia may be found, with some tenderness over the region of the internal inguinal ring, but as a rule no swelling occurs above Poupart's ligament. Of Breiter's thirty-six cases, a swelling was felt above Poupart's ligament in twenty-two. Moynihan disbelieves Breiter's contention, and corroborates his views by an examination of all specimens of properitoneal hernia in the museum of Guy's Hospital in which he found the position of the interstitial sac to be such that it precluded recognition on abdominal examination. In rare instances the content of the inguinal hernia may be reduced into the properitoneal sac, and then

the diagnosis is obvious. In those cases in which there is no accompanying inguinal or femoral hernia, it is usually impossible to make a pre-operative diagnosis.

It is only by operation or post-mortem examination that the true nature of the hernia is revealed. Many surgeons have performed a herniotomy for strangulated inguinal hernia, removed the sac, and closed the wound, but when, to their surprise, symptoms of obstruction persisted and a subsequent operation was performed, a strangulated properitoneal hernia was found.

Of the cases reported since 1900 that we have collected, thirty-four were strangulated or incarcerated, four were reducible, and in twelve no history was given. The failure to make an early diagnosis and the resultant delayed operative intervention has resulted in a high rate of mortality. Torrey in 1888 reported thirty-five cases of strangulated properitoneal hernia, with an operative mortality of 80 per cent. In our series of fifty herniorrhaphies, there were ten deaths, and in twenty cases the results were not known, making a mortality of 20 per cent. or more.

The treatment of properitoneal hernia will be considered jointly with the treatment of the other types of interparietal hernias.

#### INTERSTITIAL HERNIA

The two cases we have presented are typical of this group of interparietal hernia. (See Cases I and II.)

From an autopsy specimen, Hesselbach, in 1814, presented an excellent illustration of this variety of hernia, with the sac lying between the internal and external oblique muscles. In 1812, Cooper observed and, in 1827, published an account of the first successful herniotomy for a strangulated interstitial hernia, the sac being situated between the two oblique muscles. In 1893, Macready was able to gather 163 cases of this form of hernia from the records of the London Truss Society, but as these cases were not verified by autopsy or operative findings, their diagnosis is uncertain. Interstitial hernia in women was first described by Berger in 1891, and Auvray in 1900 reported fourteen such cases. In 1900 Gobell collected 115 cases of interstitial hernia which had been found at operation or post-mortem examination. We have been able to gather sixty-five cases from the literature and have made two personal observations, making our series a total of sixty-seven. These, added to the figures reported by Macready and Gobell, make a grand total of 345 known cases of interstitial hernia.

*Definition and Anatomical Considerations*—In interstitial hernia the sac burrows its way between the layers of the abdominal wall, and may be found in any of the following positions: (1) Between the transversalis muscle and fascia, (2) between the transversalis and internal oblique muscles, (3) between the fibres of the internal oblique muscle, or (4) between the internal and external oblique muscles, the latter being by far the most common position. Many writers contend that the only variety seen is the form in which the sac lies between the two oblique muscles. Moynihan even goes

## INTERPARIETAL HERNIAS

so far as to deny the possibility of other forms because he believes the anatomic structure of the inguinal canal is such as to preclude the formation of intermuscular hernias in this section of the canal

We have been able, however, to collect authentic cases of all four types of interstitial hernia mentioned above. Gobell reports eleven cases in which the hernial sac was located between the transversalis muscle and fascia, typifying Group 1. He also found fifteen cases in which the hernial sac lay between the external oblique muscle and the transversalis fascia, the internal oblique and transversalis muscles being deficient in this area. As in every one of his cases the hernia was incarcerated, the exact anatomical position was determined during the operation. Coley and Sultan each describe a case in which the sac is situated between the fibres of the internal oblique and the transversalis muscles (Group 2). Illustrative of Group 3, Goyrand, Berger,

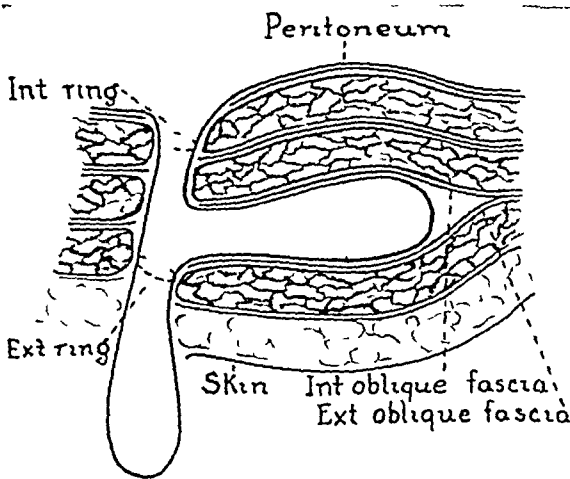


FIG 3—Bilocular interstitial hernia

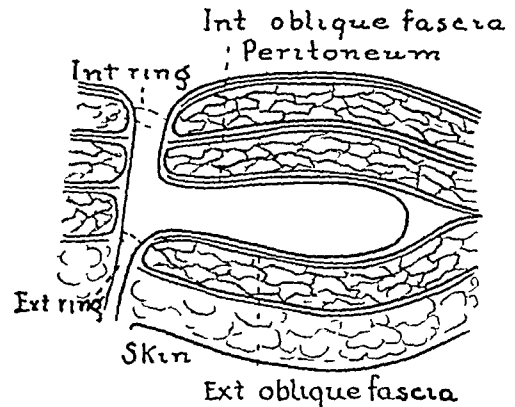


FIG 4—Monolocular interstitial hernia

and Venturoli have seen the hernial sac completely surrounded by the filaments of the internal oblique muscle. Goyrand, indeed, considers it characteristic, and believes that the hernial sac insinuates itself between the muscle fibres. In Berger's case, the man had a congenital monolocular hernia of the right side, and the hernial sac was surrounded by muscular fibres of the internal oblique muscle. Venturoli had to sever the filaments of the internal oblique muscle in order to release the incarcerated hernial sac. Group 4 consists of the intermuscular hernias most commonly encountered—those situated between the two oblique muscles. Thus it seems to us that there is definite clinical evidence as to the existence of all four varieties of interstitial hernia.

Moynihan, Halstead, and Watson all assert that an interstitial hernia must be bilocular (Fig 3). One loculus must extend down the inguinal canal through the external ring and may or may not descend into the scrotum, the other loculus must pass out between the external and internal oblique muscles, and both loculi must communicate with each other and open into the peritoneal cavity through the internal inguinal ring. However, all inter-

stitial hernias are not bilocular, for cases have been described which demonstrate that both trilocular and monolocular forms exist

In Ehler's interstitial hernia there were three sacs, one extending between the internal and external oblique muscles, one between the skin and superficial fascia, and the third descended into the scrotum. All three loculi communicated with each other and opened into the abdominal cavity through the internal inguinal ring. In the monolocular variety (Fig 4), the interstitial sac is a direct continuation of the inguinal hernia and not a diverticulum with an inguinal hernia descending farther down the canal. If the ectopic testicle is at the external ring and prevents the further descent of the hernia, the only direction in which the sac can expand is between the layers of the abdominal muscles. As there is no loculus going down into the scrotum, the hernia must of necessity be monolocular. At operation, the enterocele

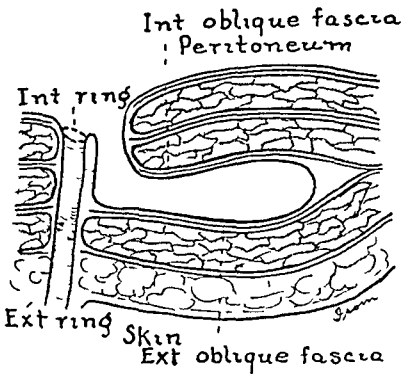


FIG 5.—The authors case of interstitial hernia occurring outside the inguinal canal

between the muscles is found to be a direct continuation of the sac that comes down the inguinal canal, while the process vaginalis is completely closed and in the majority of cases does not even descend into the malformed, empty scrotum. Gobell was able to collect reports of twenty-four such cases of monolocular interstitial hernias and eighty-four of the bilocular variety. In our series there were ten monolocular, thirty-six bilocular, and twenty-one that could not be diagnosed because of insufficient data.

In another variety of monolocular hernia the interstitial sac lies adjacent to but not communicating with the inguinal canal (Fig 5), and opens into the abdominal cavity through its own orifice, which lies near the internal inguinal ring. Kirchner describes such a case in which the sac does not involve the inguinal canal or the internal inguinal ring, but occurs as a separate and distinct entity. In the two cases which we have reported in this paper, the interstitial sac was completely outside the inguinal canal and may be classified as an extra-inguinal hernia of the interstitial variety. Perhaps some writers would consider this group as a form of ventral hernia, but its immediate proximity to the inguinal canal precludes this supposition.

*Etiology*—The same condition that contributes to the formation of properitoneal hernia contributes also to the production of the interstitial variety. The most satisfactory explanation of this form of rupture is based upon its connection with retained testicles. The testicle usually is situated at or just outside of the inguinal ring, and bars the further descent of the hernial sac, causing it to spread between the layers of the abdominal muscles. In Macready's 129 cases in males, abnormalities of the testicles were present in 73.4 per cent, and in 67.1 per cent there were congenital displacements of

the testicles In Gobell's 111 cases of interstitial hernia in males, abnormally placed testicles were present in fifty-seven, or 51.3 per cent Since 1900, forty-five interstitial hernias in men have been reported, and twenty-five (55.5 per cent) of the patients had ectopic testicles De Gaimo describes two cases in which a tube and an ovary were found in the inguinal canal mechanically obstructing the descent of a congenital hernia The cases of Macready and Gobell, combined with our series produce a total of 285 cases of interstitial hernia in males, in 186 of which the factor of retained testes was present, making a total of 65 per cent with congenital aberrant testes Macready states that in practically all hernias of this group there is a mal-development of the scrotum which prevents the normal descent of the testicle and process vaginalis Moynihan strengthens this belief by showing that the scrotum is never fully occupied by the testicle

That an ectopic testicle is not the only etiologic factor present, however, is evidenced by the occurrence of interstitial hernia in males with normally placed testicles, and in females Our series includes the records of twenty-two women in whom interstitial hernias were present

We believe that the preformed pouches of Rokitsansky play a lesser part in the formation of these hernias than in the preperitoneal variety, yet how can we explain the existence of the form of interstitial hernia which occurs separately from the inguinal canal unless we accept the premise that it developed in a congenitally preformed sac? The case of Kirchner, together with our two cases illustrates this form of hernia

*Incidence*—The incidence of interstitial hernia seems to vary, as Langton observed forty-two in 50,000 herniorrhaphies, while Remedi encountered twelve in only 760 such operations The condition occurs 3.5 times more frequently in men than in women In Gobell's series of 115 cases, four were in women Of Macready's 163 interstitial hernias, thirty-four were in females while Auvray reports fourteen and Berger eight cases in women Thus far we have been able to find 285 interstitial hernias in men and eighty-two in women The average age incidence in males was thirty-six and in females fifty-six The youngest patient reported was four months old and the oldest sixty-six

*Symptoms*—The outstanding clinical syndrome is that of intestinal obstruction, as evidenced by the fact that in Gobell's 115 cases, ninety-seven hernias were incarcerated In our series thirty were incarcerated, fourteen were reducible, and in twenty-three no history was given If a patient complains of pain in the inguinal region, is nauseated and vomits, and if examination reveals an ectopic testicle with a palpable mass above Poupart's ligament, the presence of interstitial hernia should be suspected The intermuscular swelling, however, cannot always be palpated, the testes may be in the scrotum, and the obstructive symptoms may be missing In such cases the diagnosis is difficult and, in fact, impossible In our two cases no obstructive symptoms were present Both patients complained of pain in the inguinal region which was accentuated by straining and was relieved by lying down



No inguinal mass was present. We surmised that we were dealing with some abnormal form of hernia, the exact nature of which we did not know.

#### SUPERFICIAL HERNIA

Boyer, in 1822, was the first to describe a hernia which proceeded from the external inguinal ring and spread out between the aponeurosis of the external oblique muscle and the integument. He termed it intra-inguinal hernia. In 1886, Le Fort revived interest in this variety of hernia, but it remained for Kuester, in 1887, clearly to describe and define this rare condition, which he named inguinoperitoneal hernia. He presented histories of fourteen cases and discussed the probable etiologic factors concerned in their production. In 1903, Moschowitz collected sixteen cases and added one of his own. In 1905, Sellenings published reports of a series of twenty-seven cases which he had collected. In a review of the literature we have been able to accumulate records of ninety-six cases, some of which date back to 1893 and are not included in any of the aforementioned series. We realize that it is a hopeless task to collect all reported cases because of the variety of titles and subjects under which they have been published. Many reports of so-called superficial inguinal hernias had to be discarded because of insufficient data which made it impossible to determine accurately their anatomical position.

The addition to our series of that of Sellenings produces a total of 123 authentic cases of superficial hernia.

*Definition and Anatomical Considerations*—In inguinoperitoneal hernia the sac descends into the inguinal canal, then through the external inguinal ring, and spreads out between the aponeurosis of the external oblique muscle and the skin. The sac may occupy one of three positions: (1) It may pass laterally toward the anterosuperior iliac spine. This is the most common location. (2) It may extend upward and medialward toward the umbilicus, as in Broca's case. (3) It may pass downward over Poupart's ligament and come to lie directly over the femoral opening between the deep fascia of the thigh and the skin.

Cases belonging to the last group have often been described as inguinofemoral hernia. In fact, Twyman considers them a clinical entity and reports the cases of Holthouse, Key, and his own as being representative of this variety. It seems to us that these are true inguinoperitoneal hernias, and should be so classified. An inguinofemoral hernia, as the name implies, is one involving both inguinal and femoral canals. For example, an inguinal hernia passes down the inguinal canal as far as the lower part of the canal, then because of an anatomical defect it passes beneath Poupart's ligament and emerges through the femoral opening. In Twyman's case the hernial sac came through the external inguinal ring, passed downward over Poupart's ligament, and was found in the superficial tissue in Scarpa's area. The hernia was inguinal, and never came into contact with the femoral canal, hence it is merely a superficial inguinal hernia, and should be so classified.

The bilocular theory of Moynihan again is applicable to this form of hernia, one loculus passing down into the scrotum or labia and the other passing out between the aponeurosis and the integument (Fig 6). It is true that in some cases the superficial hernia is merely a diverticulum from the process vaginalis and that the main portion of the hernia descends into or near the scrotum. On the other hand, we have found cases in which the process vaginalis is situated between the external oblique aponeurosis and the skin, there being no hernial sac descending into the scrotum. When the process vaginalis and the testicle are both ectopic, it seems that they constitute true monolocular hernia. Gobell maintains that the monolocular variety is just as prevalent in the superficial hernias as in the other forms of interparietal hernias which have been discussed so far (Fig 7). In our series of ninety-six cases of superficial hernias, thirty were bilocular, ten monolocular,

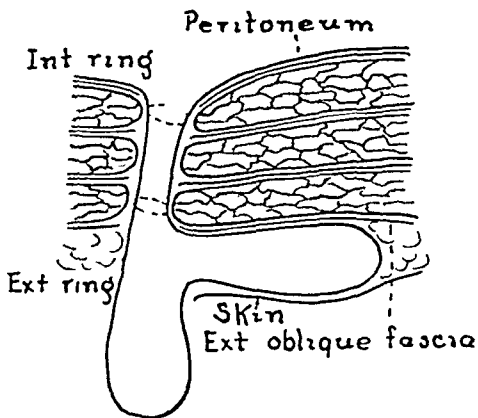


FIG 6—Bilocular superficial hernia

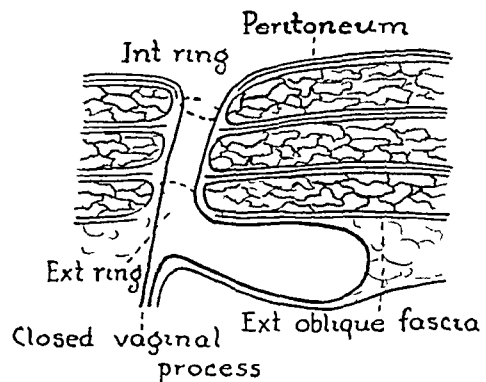


FIG 7—Monolocular superficial hernia

and in fifty-six insufficient data made it impossible to determine the nature of the interstitial sac.

*Etiology*—Practically all that has been said concerning the etiology of properitoneal and interstitial hernia could be mentioned as being causative factors in the formation of superficial hernias. The pathogenesis of this variety of hernia, however, is concerned chiefly with congenital malformations of the process vaginalis and the testicles. As a rule, both are placed between the skin and the external oblique aponeurosis, and very seldom communicate with the scrotum. In those few cases in which the process vaginalis and the testicle enter the scrotum, the superficial hernia is merely a diverticulum from the walls of the scrotal hernia. In other cases the testicle is ectopic, but the vaginal process enters the scrotum, although it is completely obliterated below the testicle. The spermatic cord usually is short, and Schmidt considers this a factor in inhibiting the normal descent of the testicle. In 1900, Gobell collected eighteen cases of superficial inguinal hernia. In all of these the testes were ectopic, in eleven the sac was bilocular, and in three it was monolocular. In our series of cases eighty-six were in males in sixty-seven of whom ectopic testicles were present.

However, as eight cases were found in males with normally placed testicles and seven were found in females, other etiologic factors must be sought. If the content of the hernial sac is suddenly increased and the scrotum cannot adequately take care of it, then the hernia must extend out between the external oblique aponeurosis and the integument. Moschowitz reports a case in which a testicle was retained in the inguinal canal. As the boy developed, the testicle gradually descended into the scrotum, but since the descent was accompanied by pain, he frequently forced the testicle and the accompanying congenital hernia back out of the scrotum. Following such a reduction, the testicle and hernia were forced out between the external oblique aponeurosis and the skin, as the external inguinal ring was too small to permit their return into the inguinal canal and abdomen. The hernia became strangulated, and at operation the sac was found to be as described. Repeated and indiscriminate taxis, therefore, may produce this form of hernia.

*Incidence*—The incidence of this group is very low. So far, only 123 cases have been described, 101 in males and seven in females, and in fifteen the sex was not mentioned. The average age is forty-five years.

*Symptoms*—The symptoms of superficial hernia usually are those of intestinal obstruction. Out of ninety-six cases, thirty were irreducible and presented symptoms of obstruction, twelve were reducible and in fifty-four no clinical history was given. In this type, a palpable tumor generally is encountered about Poupart's ligament, and when the scrotum is examined the testicle is missing. It must be remembered, however, that in a few cases the superficial sac may pass downward into the region of the femoral ring and be mistaken for a femoral hernia.

#### TREATMENT OF INTERPARIETAL HERNIA

As most interparietal hernias are either incarcerated or strangulated when the patient presents himself, immediate operative intervention is indicated. Delay merely increases the risk of mortality. If a patient presents symptoms of intestinal obstruction following an inguinal or femoral herniorrhaphy, an incarcerated properitoneal hernia should be suspected, and intervention should be instituted immediately. In all herniotomies, in order to be certain that an intermuscular sac has not been missed, the entire inguinal canal should be carefully explored. When operating on an interparietal hernia, the surgeon must remember that the strangulation may be at the internal ring, the neck of the interstitial diverticulum or sac, or the external ring. The abdomen never should be closed until the site of obstruction has been found. Generally, careful exploration will reveal the enterocele in a diverticulum.

In an operation for interparietal hernia, some surgeons prefer the inguinal approach, and then, if necessary, the incision can be extended until the abdomen is opened. Moynihan thinks that a combined abdomino-inguinal route is better. It seems to us that the latter is the more practical, as it precludes injury to the bowel, since the site of obstruction is more clearly revealed by this approach.

## INTERPARIETAL HERNIAS

In dealing with simple non-strangulated hernias, all that is necessary is to isolate the sac, ligate it, and close the hernial tract through the abdominal parietes

### SUMMARY

1 Inteparietal hernia is a term used to designate a group of hernias which occur in the inguinal region between the various layers of the abdominal muscles, and are classified according to the anatomical location of the hernial sac

2 Properitoneal hernia includes all those cases in which the hernial sac lies between the peritoneum and the transversalis fascia, 119 such cases being reported

3 In interstitial hernia the sac lies between the transversalis fascia and muscle between the transversalis and internal oblique muscles, or between the two oblique muscles, 348 such hernias having been reported

4 In superficial hernia the sac lies between the skin and the aponeurosis of the external oblique muscle We have found 123 cases of this type

5 In interparietal hernia the sac may be monolocular or multilocular, the latter being the form present in the majority of cases

6 The usual clinical picture is that of intestinal obstruction

7 Treatment consists of early recognition and immediate relief by operation

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## DUODENAL HERNIA

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WITHIN a period of three months, two cases of duodenal hernia were observed in the Surgical Service, Emory Division, Grady Hospital. They are of unusual interest in that one was of the left side and one of the right side according to the classification of Moynihan. Both cases were admitted with acute obstructive symptoms, the first diagnosed only by exploratory laparotomy with recovery, and the second diagnosed correctly but with a fatal termination.

From a search of available literature, the first description of duodenal hernia was by Klob, in 1861, who carefully described a case of the right-sided variety, though Trietz, in 1857, suggested the possibility of herniation at the duodeno-jejunal junction, describing anatomically the formation of the various folds and fossæ in this region.

A detailed analysis of reported cases was presented in 1906 by Moynihan, who, in his monograph, tabulated and explained the cases reviewed. Some one hundred case reports were embodied in this work and twenty of the patients recovered. The anatomic and embryologic interpretations of the two cases here reported are drawn from the descriptions detailed by him, though careful operative observations were made in both cases, supplemented by autopsy findings in the second case.

In order to properly report retroperitoneal hernia of this variety, it is necessary to review the embryology of the abdominal structures. The present theory is that, in common with most herniæ, a congenital potential sac must be present, which, in duodenal hernia, is formed by a fusion anomaly.

The intestinal canal at the fourth week of intra-uterine life is represented by a straight tube attached throughout its length to the mid-line of the body by a dorsal fold of peritoneum, the primitive mesentery. The stomach develops from a dorsal bulging of the tube, to which the primitive mesentery is attached, and a fold of peritoneum runs from the anterior abdominal wall, forming the lesser omentum.

By the sixth week, three segments supplied by special arteries are found. The first segment forms the stomach and duodenum and the celiac axis is contained within its mesentery. That portion of the mesentery lying behind the stomach forms, with the growth of the posterior wall of the stomach and its development to the right, the greater omentum. The head of the pancreas lies at the convex junction of the pylorus with the stomach. The distal end of the duodenum, where later the duodeno-jejunal flexure is found, lies in the median plane of the body, possesses no mesentery, and is therefore fixed to the posterior abdominal wall.

The second segment extends from the duodeno-jejunal flexure to the umbilicus and back to the posterior abdominal wall, the umbilical loop of Toldt, the two limbs of which are parallel and are united by a long, narrow mesentery containing the superior mesen-

teric artery This segment forms the jejunum, ileum, cæcum, ascending and transverse colon

The third segment begins at the splenic flexure, includes the descending colon, sigmoid and rectum, and has a short, narrow mesentery, in which lies the inferior mesenteric artery

The development of the peritoneal reflections of all the intra-abdominal organs is directly influenced by the growth of the organs themselves, and must of necessity occur within the narrow confines of the abdominal cavity The stomach first lengthens its mesentery to form the greater omentum which extends without adhesions from the greater curvature to a dorsal position in the median line near the pancreas and spleen The duodenum, with its ends stationary in the median line and its convexity behind, becomes, with the head of the pancreas, closely applied to the posterior abdominal wall, and finally by growth of other organs loses most of its mesentery The second segment unfolds and enlarges rapidly in the proximal limb but more slowly in the distal limb so that the small intestines occupy the right half of the lower abdomen, and the cæcum and large intestine are cramped into the upper left regions, later to assume slowly their normal positions The dorsal attachment containing the superior mesenteric artery trunk remains narrow and in a horizontal line Physiologic adhesions, though not thoroughly understood, fuse layers in certain locations, but not in others The fossa duodenalis divides into folds and fossæ The pancreas, though first enclosed by peritoneum, loses the posterior layer by fusion and migration The mesentery of the transverse colon blends with peritoneum covering the pancreas and the duodenum The greater omentum fuses by fusion the transverse colon and forms the phrenocolic and the hepaticocolic ligaments The final fusion is the development of the posterior abdominal wall at the expense of the descending mesocolon, which explains the position of the hernia between the stomach and transverse colon in the first case here reported

According to Moynihan, the duodeno-jejunal junction is divided into nine fossæ, but only two of these are of sufficient clinical import to justify detailed description Herniation through the remaining fossæ is extremely rare, but the proportional frequency in which each fossa is found in cases of duodenal hernia occurring either through the paraduodenal or the mesenterico-parietal fossa is given below

(1) Superior duodenal fossa, which lies to the left of the ascending portion of the duodenum, and is present in 60 per cent of all cases of duodenal hernia

(2) The inferior duodenal fossa, or fossa of Treitz, lies to the left of the ascending portion of the duodenum between the third and fourth lumbar vertebra, and is present in 80 per cent of all cases

(3) The posterior duodenal fossa lies behind the upper part of the ascending limb of the duodenum, and is usually present in some degree

(4) The duodeno-jejunal fossa lies at the base of the transverse mesocolon, and is found in about 15 per cent of the cases

(5) Inter-mesocolic fossa lies at the root of the transverse mesocolon, but runs horizontally in contra-distinction to the duodeno-jejunal fossa

(6) The paraduodenal fossa, described in 1871 by Landzert, lies to the left of the ascending limb of the duodenum and is bound above by a fold containing the inferior mesenteric vein, to the left by a fold containing the left colic artery, below by a mesocolic fold, and to the right by the mesentery of the small intestine Left-sided hernia usually occur through this fossa

(7) The mesenterico-parietal fossa of Waldeyer lies behind the superior mesenteric artery and may be found by examining the first part of the meso-jejunum The orifice is to the left and the blind extremity to the right and downward Peritoneum of the left leaf of the mesentery lines the fossa, that of the right leaf covers the blind end and then is continued directly into the posterior parietal peritoneum The second case reported occurred through this fossa

(8) The intra-duodenal fossa, which is not often present



(9) The para jejunal fossa also lies behind the superior mesenteric artery and is closely associated with the fossa of Waldyer

CASE I—(Figs 1, 3, and 4) A negro male, thirty years of age, was admitted to Emory Division of Grady Hospital at 9 30 A M, July 30, 1930, in extreme abdominal pain and shock. At 10 00 A M he had been taken with sudden, agonizing and paroxysmal pain over the entire abdomen, followed by vomiting a few minutes later and had retained nothing since. Notwithstanding the severity and constancy of the pain, he had not sought relief until twelve hours after the onset. For the past two or three hours he had been voiding an ounce or two of urine every ten or fifteen minutes and felt as if the bladder were filled. Except for a gnawing pain in the epigastrium three or four hours after meals occasionally, there have been no digestive disturbances.

The family history is unimportant and the past history is irrelevant.

The temperature was 97° Fahrenheit, pulse 84, and respiration 26. Leucocyte count was 14,100 with 81 per cent neutrophils. One-half ounce of urine secured by catheterization was negative.

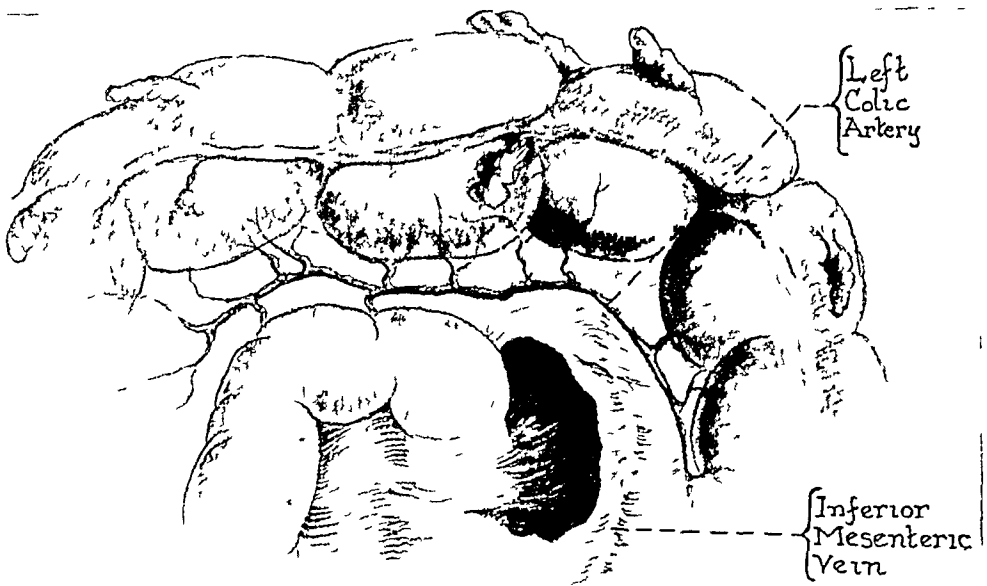


FIG. 1.—Para-duodenal fossa (Moyman). Case I. Note left colic artery lateral to inferior mesenteric vein, which lies in left and upper free-form edge of fossa.

Physical examination was negative except for a symmetrical tumor, which apparently filled two-thirds of the abdomen. The tumor was smooth and firm and filled the lower abdomen and extended in the mid-line about four centimetres above the umbilicus. There was a dull note upon percussion and the entire abdomen was exquisitely tender. A diagnosis of acute intestinal obstruction of unknown etiology was made. Under ether anaesthesia a long right rectus incision with the umbilicus at its upper third was made. A smooth, symmetrical tumor, which occupied two-thirds of the abdomen and resembled an ordinary ovarian cyst, was found. The inferior pole telescoped the bladder, the omentum was stretched over the tumor and presented a moss-like appearance, the greater curvature of the stomach lay upon the superior pole and the small intestines were not visible, nor could they be seen through the cyst-wall. The cecum was exposed with difficulty but a redundant sigmoid was easily found. The sac was incised and all the small intestines from the jejunum to the lower ileum were found within. Reduction was accomplished by unfolding the root of the mesentery, upon which the hernial orifice was found to be at the duodeno-jejunal junction. Reduction was completed by

## DUODENAL HERNIA

drawing the entire small intestine through the neck of the sac in the paraduodenal fossa. The opening was closed by purse-string sutures, avoiding the inferior mesenteric vein. Convalescence was uneventful and patient left the hospital in two and one-half weeks.

CASE II—(Figs 2 and 5) A negro male, aged twenty-two, was admitted October 9, 1930, at 7 P.M. Twenty-four hours before admission he had been taken with acute colicky pains, paroxysmal in character, beginning in the epigastrium and radiating over the entire abdomen. Persistent nausea and vomiting followed one hour later. Bowels had moved twice, the last time with considerable gas six hours before admission.

A similar attack, lasting six or eight hours, occurred when he was eleven years of age.

When admitted he was in acute pain with knees drawn up. The slightest palpation over any part of the abdomen was extremely painful, and marked rigidity, particularly on the right side, was present. The abdomen was domed-shaped and though a definite palpable mass was not present, inspection revealed a ridgelike elevation running from a point to the right and below the umbilicus to the left upper quadrant with definite

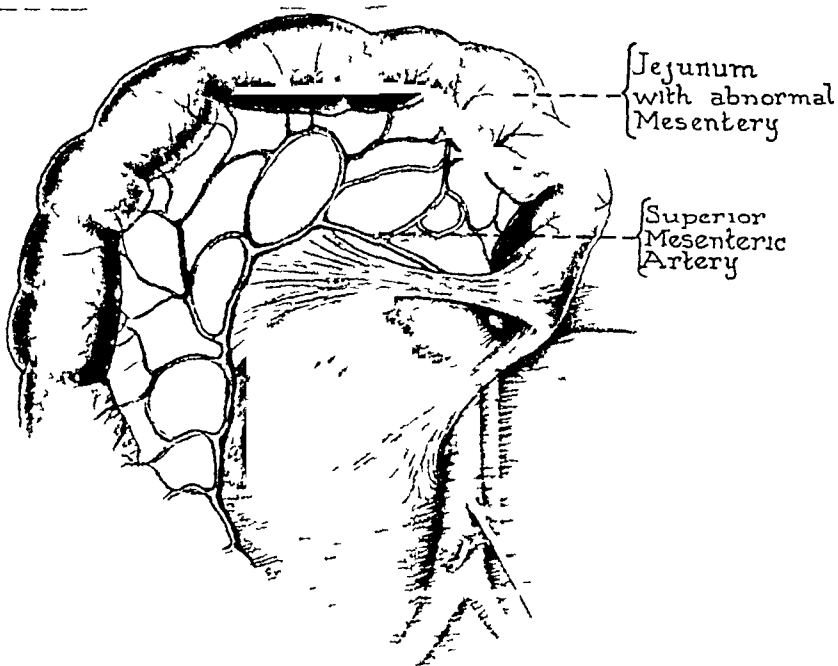


FIG. 2.—Mesenterico parietal fossa of Waldeyer (Moynihan) Case II. Jejunum is shown raised upward and to left. Note superior mesenteric artery along superior and mesial border of fossa.

flatness throughout the rest of the abdomen. The temperature was 98° Fahrenheit, pulse 90, and respiration 30.

Under spinal anaesthesia a long right rectus incision was made and a large amount of dark reddish fluid escaped from the peritoneal cavity, after which four or five feet of gangrenous distended small intestine were extruded into the wound. There was a mass lying under the posterior parietal peritoneum extending from just above and to the left of the umbilicus, obliquely downward and occupying the right side of the abdomen. The colon occupied its normal position and it was found that the two loops of gangrenous intestines entered an opening at the root of the mesentery about the level of the umbilicus. All the small intestine except four or five inches of viable terminal ileum and a four-foot loop of gangrenous ileum lying free in the abdominal cavity were found in the sac. An enterostomy was performed after resection of the gangrenous loop, but no further operative procedures were carried out because of the precarious condition of the patient. Death occurred twenty-four hours later and the autopsy findings confirmed the diagnosis.

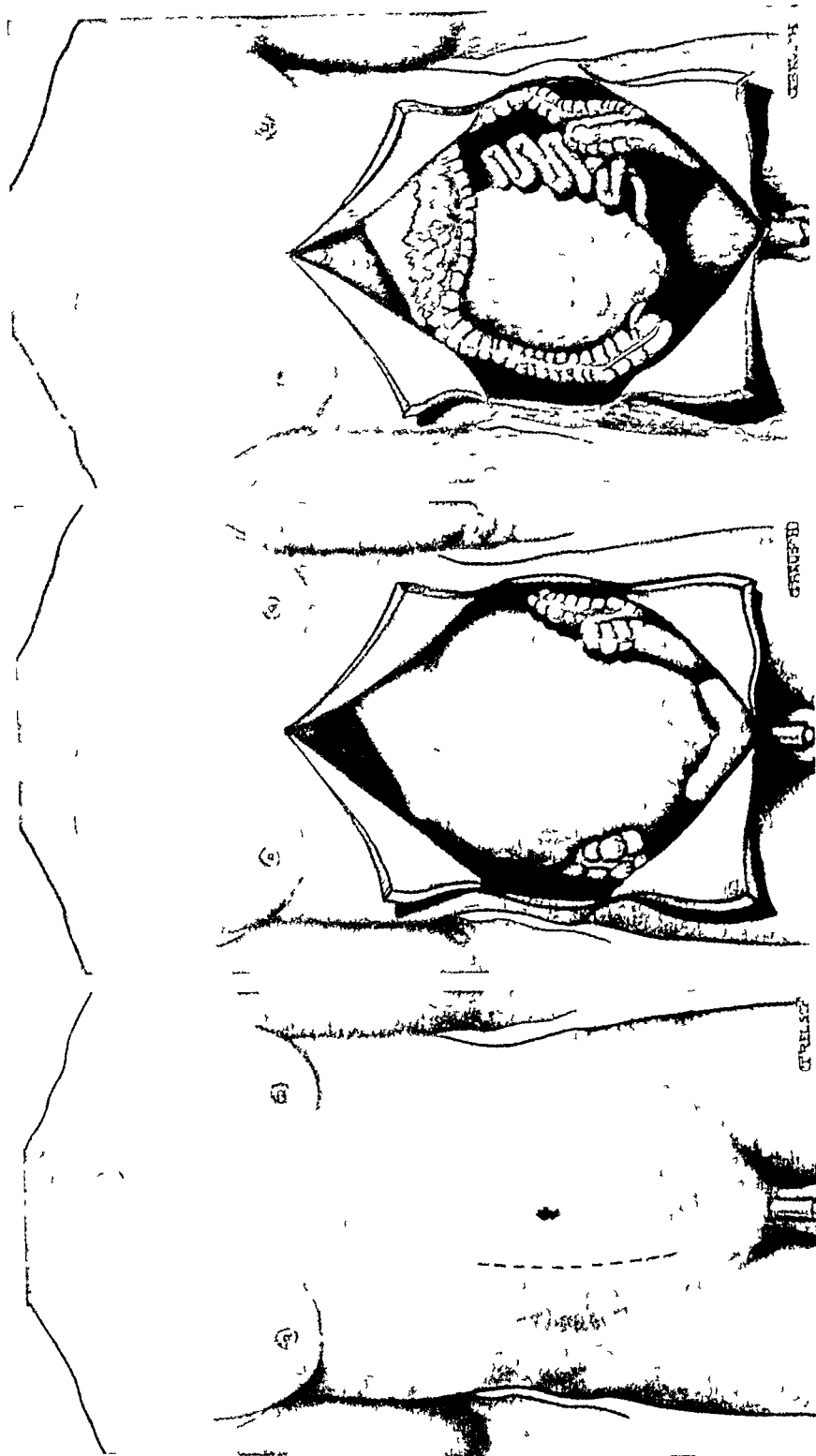


FIG 3

FIG 4

FIG 5

FIG 3—Case I Before incision Symmetrical tumor is clearly shown A slight break in the symmetry of the tumor is found at the left costal margin but is not shown

FIG 4—Case I Operation with recovery but artist has shown wide dissection in order to demonstrate pathology Omentum is shown stretched over tumor, which telescopes the bladder Transverse colon lies posterior to the lower pole

FIG 5—Case II Shows gangrenous terminal ileum outside the sac though the intestine within the sac was viable The gangrene was due to traction upon and consequent thrombosis of the intestinal branches of the superior mesenteric artery The terminal four inches of ileum and cecum were not gangrenous because the ileo colic artery was not thrombosed

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The first case was free from symptoms for eight months, at which time he was admitted with symptoms very similar to those originally present, except to a lesser degree, but operation revealed only multiple abdominal adhesions probably due to trauma from drawing the entire small intestine through the hernial orifice, but there was no evidence of a recurrence of the hernia. The adhesions were released and convalescence was uneventful, the patient leaving the hospital at the end of the third week. He is now clinically well.

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# THE RONTGENOGRAPHIC VISUALIZATION OF THE ARTERIES OF THE EXTREMITIES IN PERIPHERAL VASCULAR DISEASE

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IN THE care of vascular disease of the extremities, an accurate pre-operative determination of the state of the circulation should be made. To accomplish this end many tests have been devised to ascertain the influence of vasomotor spasm, the adequacy of the collateral circulation and the patency of the main channels. Recently, in the publications of Brown,<sup>3</sup> White<sup>18</sup> and Morton and Scott,<sup>13</sup> tests for the evaluation of vasomotor overactivity have been suggested. The latter authors have demonstrated<sup>13</sup> the normal vasomotor gradient and the usual level of vasodilatation under given conditions and hence have been able to estimate, in any given case, how much of the peripheral vascular insufficiency is due to vasospasm and how much to organic obliteration.

In the large group of obliterative vascular diseases there have been no safe, exact methods for the determination of the state of the vessels. It is well known that in some of these disorders—for instance, thrombo-angitis obliterans—the main arteries are apt to be occluded and the circulation carried on by the smaller collateral vessels. On the other hand, as is frequently the case in peripheral arteriosclerosis, the smaller arterioles may be obliterated while the larger trunks remain patent. Thus it follows that investigation of the arterial circulation in patients with organic involvement of the vessels should include information concerning not only the main channels, but also the smaller arteriolar branches. This is especially necessary if surgical intervention is contemplated. In the past, many indirect methods have been applied to achieve this end. The condition of the major arteries may be determined by palpation for perceptible pulsation in the vessels, by the application of the Pachon oscillometer or by the use of the recording sphygmomanometer.<sup>14</sup> Occasionally, valuable information is obtained from a plain rontgenogram demonstrating calcification of the vessels, but this gives no indication of the patency of the lumen. The circulation in the arterioles and sub-papillary network of vessels may be judged by the appearance of the part, its temperature, its reaction to elevation or dependency, by the return of the color after blanching, by the absorption of intradermal saline or histamine, by the Moschowitz test or other similar tests. Any one or all of these methods may give valuable information of an indirect nature and some of them should always be included in the routine physical examination of patients with these disorders. For the most part, the methods of physical examination by a competent observer will serve, without the use of special

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tests to distinguish between the cases of mild and severe arterial obliteration. But in many instances no such definite differentiation can be made and even with the use of all available tests there remains a legitimate doubt of the extent of the damage.

The direct visualization of the arterial tree with the main trunk, the branches and the arterioles is of inestimable value. If the site and the extent of the involvement are known appropriate therapy may be advocated. Useless amputation may be avoided, or, if amputation is indicated, it may be advised with the conviction of its necessity and the exact level determined to assure vascularity of the stump.

Since the desirability of arterial visualization is so obvious, it is not surprising that many investigators have sought to perfect a method for its use. Moniz,<sup>12</sup> Haivier and Lemaire,<sup>10</sup> Brooks,<sup>2</sup> Singleton,<sup>17</sup> Carnett and Greenbaum,<sup>6</sup> Saito, *et al*,<sup>15</sup> and others,<sup>1, 4, 5, 7, 8, 9, 11, 16</sup> have reported on arteriography. In general, sodium iodide or iodized oils have been the opaque media selected. It has been found that these substances possess disadvantages. Sodium iodide in the concentration used has resulted in damage to the vessels with increase in pain and gangrene, in symptoms of poisoning, and in death. The iodized oils, on the other hand, all have the common fault that the injection of any fatty substances into the blood-stream may lead to fat embolism with serious consequences and even death. Some authors have not stressed these results even when deaths have occurred in their cases. With the deleterious results following the use of these two substances, it is apparent why arteriography has never gained wide acceptance. But there is every reason to advocate the procedure as a diagnostic method. The fault has been with the opaque media used for the purpose. Consequently, we have been on the alert to find a medium which would give sufficient contrast to outline the vessels but which would have no deleterious local or general effects.

Many substances, including "uroselectan," have been tried out on animals in this laboratory without success until sodium-monoiodo-methane sulphonate (methiodol) was found to be a satisfactory material for the purpose. These laboratory studies will be published elsewhere. With the production of sodium-monoiodo-methane sulphonate\* for intravenous pyelography, a compound was available for arterial visualization that fulfilled the necessary requirements, namely:

(1) The drug has already had a wide clinical use for intravenous pyelography and its safety with a dose of forty grams has been demonstrated. Only twenty grams or less in a 40 per cent solution are required for arteriography, so that the fear of a general deleterious effect is eliminated.

(2) The solution in the concentration used is sufficiently radio-opaque to give sharp definition of the vessels.

(3) Experiments on animals and clinical trials revealed no deleterious

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\* Marketed as "skiodan" by the Winthrop Chemical Company

effect even on the damaged vessel walls. Evidence of thrombosis was never found.

*Animal Experiments*—Before methiodol was injected into patients with vascular disease it was necessary to prove its compatibility with the vessel endothelium and so somewhat higher concentrations were used than is necessary to produce good arteriograms.

Eight experiments were done on dogs. These were designed to determine if possible whether the drug caused irritation of the wall of the artery. A 40 per cent solution of methiodol produced satisfactory arteriograms while a 50 per cent solution was used in all of these experiments to intensify any deleterious effects upon the blood-vessel endothelium. There is, of course, the criticism that the normal vessel may withstand greater concentrations than the diseased but clinical trial has so far been innocuous in our hands.

The following experiments were done: (a) The solution was injected continuously for five minutes into the artery, (b) a segment of artery was isolated, the blood expressed from it, and a loop excluded by rubber-shod clamps. This closed segment was filled with the solution for from one to five minutes before the clamps were removed and the circulation through the segment reestablished. In this way it was felt that the maximum concentration was in contact with the vessel wall for as long as would ever occur in clinical use.

At the end of twenty-four hours and forty-eight hours, the specimens were examined, and sections were taken for histologic study. In no case was there gross or microscopic evidence of thrombosis or injury to the intima.

*Clinical Cases*—Encouraged by the lack of any harmful local action on the vessel wall in the experiments on dogs, it was decided to use the drug in clinical cases of obliterative vascular disease. The drug is dissolved in fresh, glass distilled water, carefully filtered and sterilized by boiling. At first a 50 per cent solution was used but it was later found that a 40 per cent solution was satisfactory and even lower concentrations will serve. The operative method is as follows. Without using a tourniquet, the femoral artery is exposed in Hunter's canal and is separated from the femoral vein and nerve. The cassette containing the film is placed beneath the leg under the drapes and the Rontgen tube centred over the area to be studied. The artery is picked up on a tape and compressed between the thumb and finger to prevent admixture of the solution with blood. The vessel wall is punctured obliquely with a new, sharp, No. 20 gauge needle to which is attached a fifty cubic centimetre syringe containing the methiodol solution. Injection is begun and after about twenty-five cubic centimetres of methiodol have been injected the film is exposed while the solution is still being forced into the artery. The injection is stopped without removing the needle while the film is changed. Then after injecting an additional twenty-five cubic centimetres, the second exposure is obtained while the last five cubic centimetres of the solution are being forced into the artery. After withdrawing the needle the pressure on the artery is released and a moment's pressure with a

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sponge stops all bleeding. The elapsed time from the beginning to the end of the injection should be ninety seconds or less. This is a very important part of the technical procedure. There is a remarkable absence of bleeding with the arterial puncture done in this manner. One patient with a systolic blood-pressure of 280 millimetres of mercury was operated upon and not more than three or four drops of blood escaped from the puncture wound.

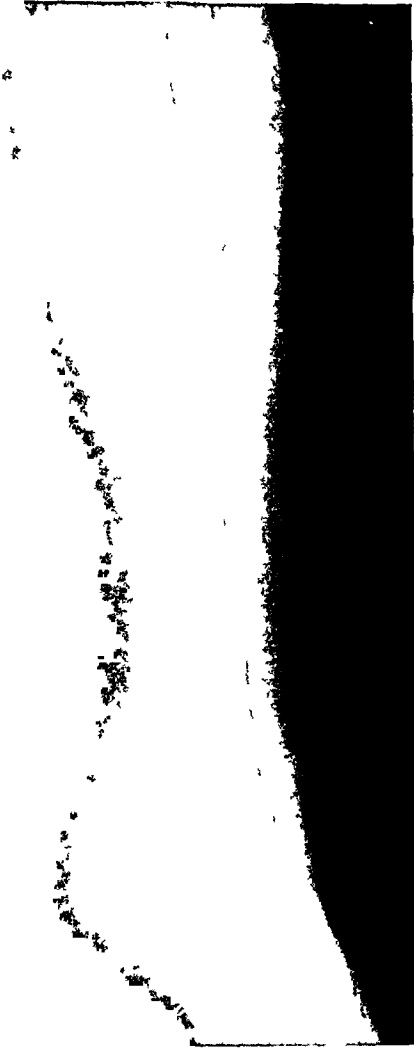


FIG 1



FIG 2

FIG 1—Case I. All of the major arteries have been occluded and the circulation is being carried on by collateral channels. The arrow points to an anastomotic loop which fills the lower part of the posterior tibial artery.

FIG 2—Case IV. An arterial injection showing patent main vessels in the leg. The arrows point to the well filled dorsalis pedis and posterior tibial arteries.

In all, eight cases were operated upon. In one instance the femoral artery was so sclerosed that very little of the solution could be injected so that this case was excluded. A brief resume of the remaining seven cases is given.

### CASE REPORTS

CASE I—F F, No 44,975. The patient was a seventy-three-year-old woman, a diabetic of eight years' standing who entered the clinic with diabetic gangrene of the right foot. The peripheral arteries were pulseless, the foot was cold and cyanotic and



there was pallor with elevation and rubor with dependency. The gangrenous areas extended from the first and fifth toes up on to the lateral margins of the foot.

The day after admission, under spinal anesthesia, the femoral artery was injected with seventy cubic centimetres of 50 per cent methiodol solution. The roentgenograms shown in Fig. 1 revealed marked impairment of the arterial circulation. A low thigh amputation was done and the patient had an uneventful convalescence.

CASE II—M. A., No. 45,369. The patient was a sixty-year-old woman, a diabetic, who has had symptoms of vascular insufficiency in the right leg and who developed an ulcer on the right foot seven weeks ago. Four weeks before admission a peri-arterial sympathectomy was done in another hospital without relief of symptoms.

For the past eight years she has known that she had hypertension (systolic blood-pressure ranges from 200 to 280 millimetres of mercury) and two years ago she had a transient hemiplegia. On examination the foot was cold, pulseless, and discolored, with a shiny skin. There was marked muscle atrophy, the nails were hypertrophied, and the color of the foot was markedly changed by a shift in position. There was gangrene of the third and fourth toes involving the web space and extending on to the dorsum of the foot.

Under general anesthesia the femoral artery was injected with sixty cubic centimetres of 50 per cent methiodol. The films showed that all of the major vessels were obliterated and only a few of the smaller collaterals remain. A mid-thigh amputation was done and aside from delayed healing of the stump, the convalescence was uneventful.

CASE III—W. B., No. 33,460. The patient, a seventy-one-year-old man, a diabetic, had a Gritti-Stokes amputation of the right leg for diabetic gangrene a year before the present admission. He now entered the clinic complaining of a cold, painful, discolored left foot. Examination revealed the foot to be a reddish plum color with pigmentation of the skin of the calf. The muscles were atrophic, the skin was dry and glistening, the nails were hypertrophied, the skin was colder than normal and the dorsalis pedis and posterior tibial arteries did not pulsate. The popliteal pulsation was felt and the recording sphygmomanometer showed a normal popliteal pulse.

Under local infiltration anesthesia, the popliteal artery was exposed and thirty cubic centimetres of 50 per cent methiodol injected. The artery was so deep in the wound that a right-angle needle designed for peritonsillar infiltration had to be used. During the course of the injection the patient complained of cramps in the leg which ceased as soon as the injection was discontinued. This was thought to be due to the hypertonicity of the solution.

The roentgenograms revealed only moderate involvement of the arterial tree and a popliteal vein ligation was decided upon and performed.

After operation the color and temperature of the foot improved and pain ceased. At the time of discharge, in his own words, "was a lot better." There was no evidence of a harmful effect of the arteriogram and a follow-up examination six weeks after operation revealed continued improvement.

CASE IV—A. R., No. 46,568. The patient was a forty-year-old woman, a diabetic who entered the hospital with gangrene of the foot of two weeks' duration. Examination revealed a toxic, sick woman with gangrene of the first toe and medial side of the foot. There was sclerosis of the peripheral vessels with marked swelling and oedema of the foot and lower calf. The discharge from the affected area was very foul and gas bubbles were demonstrated by roentgenograms.

Immediate operation was done under spinal anesthesia. The femoral artery was exposed in Hunter's canal and injected with thirty cubic centimetres of 50 per cent solution of methiodol. The leg was amputated through the mid-thigh and the wound left open. Convalescence was uneventful. The wound closed by second intention and the bone was covered by drawing down the flaps with skin traction.

The arteriogram (Fig. 2) showed the main vessels and collateral channels to be

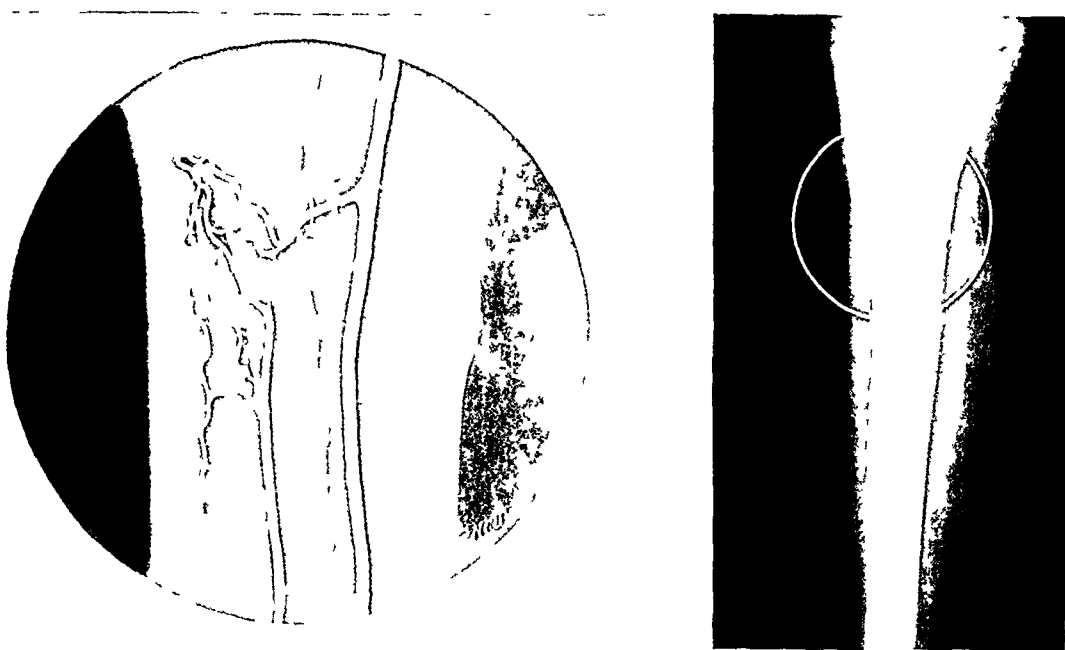
## VISUALIZATION ARTERIES OF EXTREMITIES

patent down to the level of the ankle. Amputation might have been avoided if the patient had been seen earlier, before gas-bacillus infection had occurred.

**CASE V—B McS, No 46,563** This case was a sixty-two-year-old male who was admitted with the complaint of chronic ulcers on the foot of nine months' duration. A few days prior to admission gangrene of the great toe developed. The foot was blue, cold and pulseless. There were foul-smelling indolent ulcers over the heads of the first and fifth metatarsals and early gangrene of the great toe was apparent. The urine was sugar-free and the blood-sugar level was normal, so the lesion was considered to be on an arteriosclerotic basis.

Under spinal anaesthesia, the femoral artery was injected with thirty cubic centimetres of 50 per cent methiodol. The arteriogram showed in Fig 3 slight involvement of the major arteries and obliteration of many of the collaterals. A mid-thigh amputation was done. The patient had a slow convalescence from poor healing of the stump.

**CASE VI—L M, No 46,106** The patient, a woman of sixty years, entered the hospital with symptoms of myocardial failure of six months' duration. Two days before



**FIG 3—Case V** The arteriogram shows a normal popliteal and upper posterior tibial arteries. The anterior tibial is obliterated at its origin. So much of the detail of these films is lost by reproduction that a drawing was made of an actual tracing to show the anastomotic loops like a "Medusa head" around the point of obliteration of the anterior tibial artery.

admission she began having pain in the right leg. Examination revealed the classical symptoms and signs of rheumatic heart disease with mitral stenosis and auricular fibrillation. The right leg was cold, blue, pulseless and tender. There was beginning gangrene between the third and fourth toes. The popliteal pulse was perceptible. A diagnosis of embolism of the lower part of the popliteal artery was made. Too great an interval had elapsed for embolectomy.

Under ether anaesthesia the femoral artery was injected with forty cubic centimetres of 50 per cent methiodol solution. Photographs of the roentgenograms are shown in Fig 4. The filling of the collateral branches is well shown. A drawing of the embolus is shown in Fig 5. A low thigh amputation was done, the patient made an uneventful recovery.

**CASE VII—M E, No 47,302** The patient was a sixty-seven-year-old woman, a diabetic, who entered the clinic with gangrene of the third toe, left, which originated from an infection of two weeks' duration. Examination showed gangrene of the third toe with involvement of the base of the second and fourth toes with oedema of the foot.

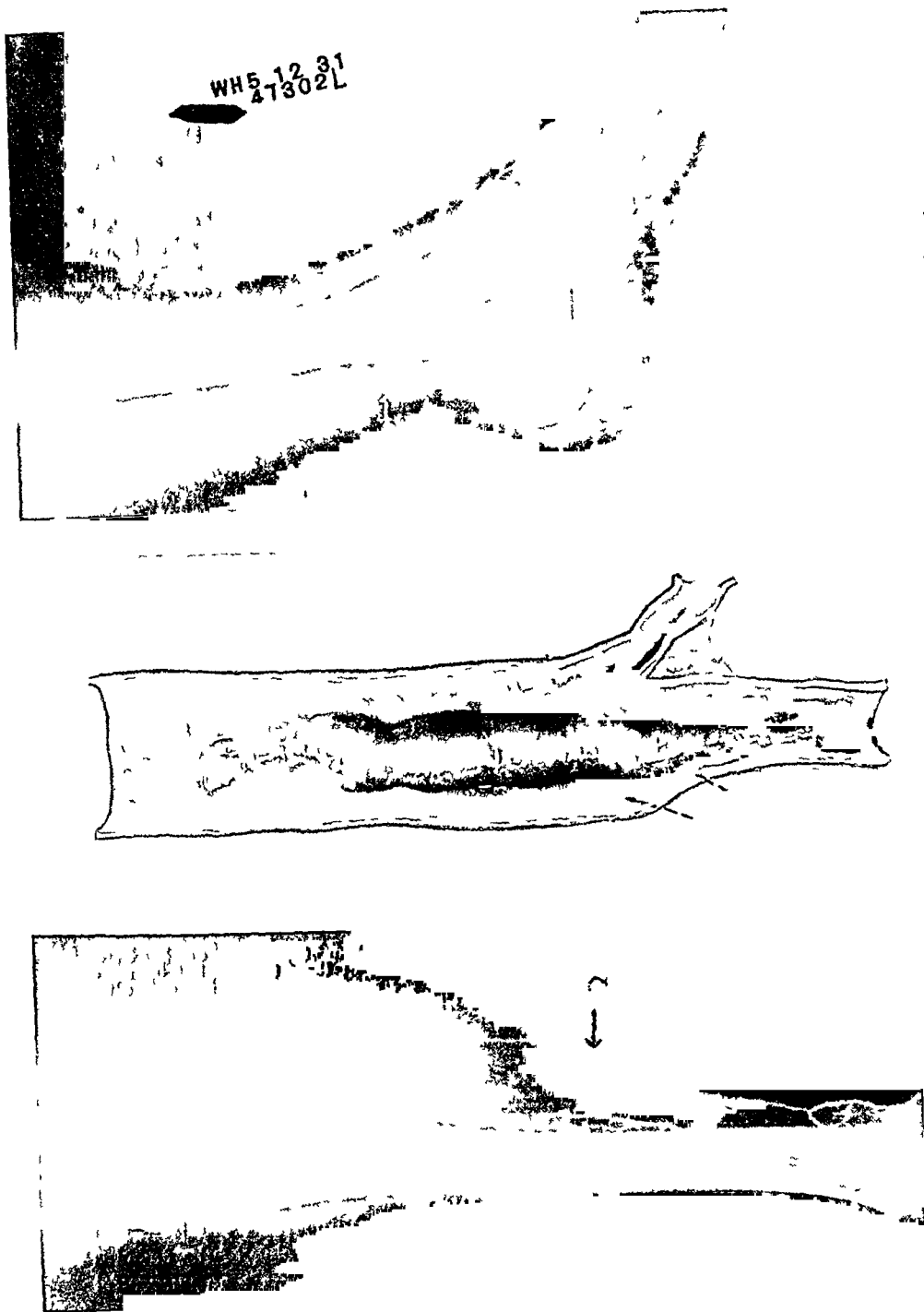


FIG 6

FIG 5

FIG 4

FIG 4—Case VI The popliteal and posterior tibial arteries are obstructed. The anterior artery is occluded at its origin, but is filled by the anterior tibial recurrent artery which connects it with the crural anastomosis about the knee joint (arrow 1) Arrow 2 points to a long anastomotic branch from the femoral artery which fills the posterior tibial at the level of the ankle

FIG 5—The location of the embolus in the popliteal artery in Case VI

FIG 6—Case VII The dorsalis pedis and other smaller vessels are well filled

## VISUALIZATION ARTERIES OF EXTREMITIES

and signs of a sub-plantar fascial abscess. The dorsalis pedis pulse was present but that of the posterior tibial was absent, however, the clinical impression was that the circulation was adequate.

Under spinal anaesthesia the femoral artery was injected with thirty-five cubic centimetres of a 40 per cent methiodol solution. It will be seen from Fig 6 that this concentration was sufficiently radio-opaque to give a good arteriogram and the films reveal that the clinical impression of the circulation was confirmed.

The second, third and fourth toes were amputated and the sub-plantar fascial abscess was drained. The patient made a good recovery from the operation and there was no indication that the arterial injection did harm to the peripheral vessels of the leg.

**DISCUSSION**—In two instances, amputation was not done after the injection and there was no indication of a detrimental effect from the arteriogram. In the remaining five amputated cases, dissection of the vessels revealed no damage to the intima or thrombosis resulting from the injection. In one case the popliteal artery was injected. This is not recommended for the deep wound prevents easy injection and might well embarrass the surgeon in case of haemorrhage. The exposure of the femoral artery in Hunter's canal is easier, permits of more accurate injection and allows the surgeon to retain command of the situation under any circumstances.

The cases presented have all been instances of obliterative arterial disease. It is conceivable that the method could be used to demonstrate many other pathologic processes. Among these may be mentioned aneurism, arterio-venous communications, deep phlebitis, the state of the perforating branches of varicose veins and the demonstration of tumors. In fact, work has already been done in this clinic using the method for cerebral arteriography in cases of brain tumor. The future will decide the indications for use of the method in other conditions but if it is restricted to the obliterative arterial diseases alone, this should be of sufficient value to justify it.

### SUMMARY

(1) A method of arteriography using sodium-monoiodo-methane sulphonate (methiodol) has been proposed. This substance in a 40 per cent solution is sufficiently radio-opaque to give good definition of the vessels of the leg. No local or general harmful effect from the intra-arterial injection of this substance has been noted in our cases.

(2) The experience with animal experiments and with seven cases of obliterative arterial disease of the extremities is reported.

(3) Illustrations are given of the accurate definition of the site and the amount of arterial obstruction in cases of obliterative vascular disease.

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# GANGRENE OF THE FINGER FOLLOWING DIGITAL NERVE BLOCK ANÆSTHESIA

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DURING the past two years I have seen four cases of such unusual interest and importance as to warrant recording them in surgical literature. These four patients presented almost identical histories, clinical course, treatment, and complications, thereby practically eliminating the element of chance in the occurrence of the unfortunate end-result in each instance.

All text-books on general surgery and anæsthesia and the special monographs on the hand speak of the ease with which operations may be done on the distal half of the finger with the aid of digital nerve block anæsthesia. The usual description of this procedure includes proper sterilization of the finger and hand, the application of a tight tourniquet (catheter or rubber band) about the base of the finger and the injection of 5 per cent or 1 per cent freshly prepared novocaine solution on the lateral aspects of the finger just beyond the tourniquet so as to infiltrate the digital nerves and the tissues surrounding them. The reason given for the use of the tourniquet is that it prevents rapid absorption of the novocaine solution by lymphatics, thereby prolonging the period of anæsthesia which, under ordinary circumstances, varies from twenty minutes to one and one-half hours. Following completion of the operation, the tourniquet is removed and sensation returns soon after.

I venture to say that this procedure is executed daily hundreds of times the world over. That it is not without danger and presents serious drawbacks as it is ordinarily carried out, is evidenced by the fact that each of the following four cases, twenty-four to forty-eight hours later, developed a dry gangrene of the finger distal to the point of injection of the novocaine, necessitating amputation. As far as I am able to determine, this complication has not been described before.

## CASE REPORTS

CASE I.—M. L., male, aged forty-three years, was referred by Dr. C. H. Fornell fifteen days after the receipt of an injury to the left thumb. On March 11, 1930, a piece of a needle from a sewing machine entered the left thumb, lodging in the nail bed at about the level of the lunula. On the following day, he consulted a physician who, after placing a rubber band tourniquet tightly about the base of the thumb and injecting novocaine solution on the dorsum distal to this point, removed the needle. The tourniquet was removed after a half hour. Two days later, a bluish discoloration of the end of the thumb was first noted. This gradually became more pronounced until a bluish-black hue was noted. A definite line of demarcation developed at about the level of the interphalangeal joint. Three or four days later the patient began to experience severe pain.

When I saw the patient, he presented a well-defined dry gangrene of the left thumb with an irregular clear-cut line of demarcation at the level of the interphalangeal joint (Fig 1) There was no sensation in the gangrenous area and needle puncture drew no blood There was an area of marked hyperæsthesia just proximal to the line of demarcation, but there was no evidence of infection X-ray examination was negative, as were also urinalysis, blood sugar, and Wassermann Partial amputation of the thumb was advised, but the patient persistently refused to have this done A spontaneous amputation resulted by the end of August, 1930 Since then the patient has been well

CASE II—Miss J P, aged twenty-nine years, was referred by Dr M L Pinco eleven days after the original injury On February 9, 1931, she accidentally stuck a pin into the right middle finger near the paronychia tissue on the outer side On the following day, severe pain was experienced and she consulted a physician who stated that infection was present and advised incision After placing a rubber-band tourniquet tightly about the base of the finger, he obtained digital nerve block anæsthesia with 1 per cent novocaine injected on both sides A small incision was made and a drop or two of pus was obtained The tourniquet was removed after fifteen minutes On the following day it

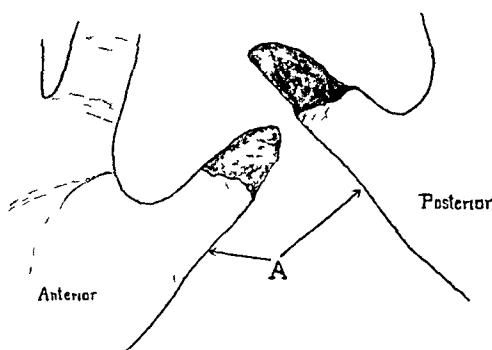


FIG 1

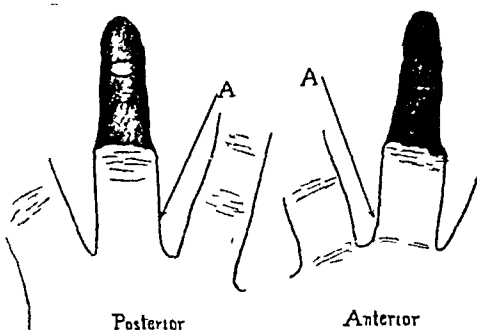


FIG 2

FIG 1—Sketch of condition found in Case I, showing the well defined line of demarcation "A" indicates the approximate site of application of tourniquet

FIG 2—Case II The well defined line of demarcation is indicated "A" marks the site of application of tourniquet

was noted that the distal half of the finger was blue and cold The color became progressively darker during the next few days and the part was anæsthetic

Examination eleven days after the injury showed a symmetrical dry gangrene of the right middle finger with a clear-cut line of demarcation about one-quarter of an inch distal to the proximal interphalangeal joint (Fig 2) The gangrenous area was completely anæsthetic and needle puncture drew no blood All the laboratory examinations were negative

On February 21, 1931, the finger was amputated at the proximal interphalangeal joint The wound was left wide open Healing took place by granulation and was complete by March 28, 1931 She has remained well

Pathological examination of the amputated finger showed thrombosis of the digital vessels The thrombi were apparently well organized The nuclei of the connective tissue cells were very indistinct (Fig 3)

CASE III—W K, aged twenty-nine years, was first seen two weeks after a splinter of wood entered the pulp of the right index finger at its tip An anterior closed space infection apparently developed which was treated with wet dressings for two days, followed by incision without anæsthesia at a hospital As the pain was not relieved, the patient consulted a physician who, after placing a small catheter tightly about the base of the finger, obtained nerve block anæsthesia with 1 per cent novocaine solution by lateral injections An incision was then made The part was then soaked in warm

## POST NERVE BLOCK DIGITAL GANGRENE

Epsom salts solution On the following day the dorsum of the finger distal to the distal crease was blue, while the anterior aspect appeared dead white By the fifth day the end of the finger was black and malodorous

Examination two weeks after the original injury showed a symmetrical gangrene at the end of the right index finger with gangrenous necrosis of the skin and subcu-



FIG 3—Case II Microscopical section of amputated finger taken transversely through the level of the nail base Section made after decalcification The organized thrombi in the digital blood vessels are visualized

taneous tissues on the dorsum of the entire finger (Fig 4) The line of demarcation anteriorly was at the distal flexion crease The whole finger was exquisitely tender due to infection beneath the gangrenous skin on the dorsum All laboratory examinations were negative Partial amputation was advised and carried out through the centre of

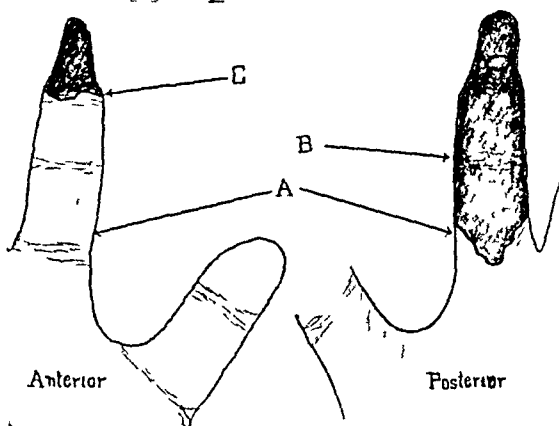


FIG 4

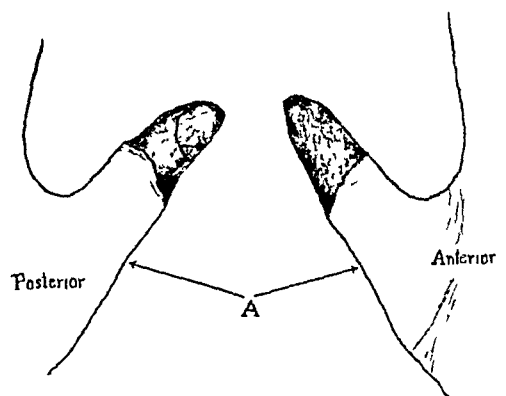


FIG 5

FIG 4—Appearance of finger on first examination in Case III 'A' indicates the site of application of tourniquet 'B' represents the area of gangrenous skin on the dorsum 'C' represents the line of demarcation anteriorly at the level of the distal flexion crease

FIG 5—Diagrammatic sketch of condition found in Case IV, showing the well defined line of demarcation on all aspects of the thumb 'A' represents the exact site of application of the tourniquet

the middle phalanx The necrotic skin on the dorsum was excised Healing took place by granulation without incident The amputated finger was too necrotic for satisfactory microscopical section

CASE IV—L L, aged twenty-two years, was seen in consultation with his physician on January 10, 1931 Four days before, a piece of needle accidentally entered the pulp



of the left thumb. The patient immediately went to his doctor who, after much difficulty, removed the foreign body. The operation apparently was performed under strict aseptic precautions. After skin sterilization, a small rubber catheter was placed snugly about the base of the thumb. Digital nerve block anesthesia was obtained by injecting freshly prepared 1 per cent novocaine solution laterally. About 6 cubic centimetres of this solution were used before anesthesia was complete. The operation lasted a little over an hour. Upon removal of the tourniquet, bleeding was moderate. That night, the pain was very severe. On the following day, the end of the thumb was dark blue and anesthetic.

Three days later examination showed a symmetrical dry gangrene of the end of the left thumb with a well-defined line of demarcation at the distal flexion crease (Fig. 5). There was no evidence of infection. General physical examination was negative. Urinalysis, blood examinations and X-ray were negative. Partial amputation was advised and was carried out by the attending physician. Healing took place without incident. Unfortunately, the amputated finger was not preserved.

*Discussion*—It is of interest to speculate as to the exact mechanism behind this unusual occurrence. Each patient was a young adult and presented nothing abnormal on general examination. There was no evidence of arterial disease and all laboratory studies were negative. It would seem, therefore, that the cause was a local one. When the first case was seen, it was thought that, possibly, the novocaine solution had been injected directly into the digital vessels, causing thrombosis. Subsequently, this was considered highly improbable. In no instance was an occlusive dressing used after operation, nor was a carbolic salve applied. In each case, wet dressings of saline, boric or magnesium sulphate solution were used and these were not unusually hot.

It will be remembered from the case reports that the attending physician placed a rubber-band or catheter tourniquet *tightly* about the base of the finger before injecting the anesthetic solution. This would produce two effects, marked local slowing of the blood-stream and local pressure injury to all tissues included in the constricting effect of the tourniquet. I believe that the question of the sterility of the novocaine solution can be answered by the absence of subsequent infection at the site of injection. However, it is probable that the mechanical presence of the solution in the tissues just distal to the point of constriction of the tourniquet was an added factor in the development of the gangrene. Individual idiosyncrasy to novocaine might be considered as a possible etiological factor. However, three of the patients had had previous experiences with novocaine anesthesia, with no unusual or untoward effects.

After consideration of all the facts, it would seem reasonable to assume that the mechanism of production of the gangrene was as follows. The tight application of a thin tourniquet caused marked local slowing of the blood-stream and tissue injury included in its constricting effect. The latter caused injury to the endothelial lining of the digital vessels, thus favoring thrombosis. The injection of a solution distal to this point constituted an additional mechanical insult, further favoring thrombosis. That all the digital vessels were not involved in each instance is evidenced by the fact that, in

two cases, the gangrene was not symmetrical and presented an irregular line of demarcation. Microscopical section of one of the amputated fingers showed definite thrombosis of the digital arteries.

I believe a real lesson is to be learned from these four cases. In the first place, it is distinctly hazardous to use a tourniquet of narrow calibre because the local tissue injury is more centralized. A broad application is safer. Secondly, for the usual incision and drainage, it is unnecessary to occlude the arterial supply by tightening the tourniquet as far as it can be pulled. The purpose of the tourniquet is to prevent rapid absorption of the anæsthetic agent and not to obtain a bloodless field. If the latter is necessary, as in looking for foreign bodies, a properly applied Esmarch bandage is more effective and certainly safer. If these facts are remembered and if the necessary precautions are taken, the complication described in this communication should never occur.

## CONCLUSIONS

(1) Four cases of gangrene of the finger following digital nerve block anæsthesia are described.

(2) After careful consideration of all the available facts, the cause for this complication is undoubtedly a local one.

(3) The essential factor is a thrombosis of the digital vessels produced by the tight application of a narrow tourniquet which causes local tissue injury and marked slowing of the blood-stream. An added factor may be the mechanical presence of the anæsthetic agent distal to the point of constriction of the tourniquet.

(4) The prevention of complications of a similar nature rests with the care with which a tourniquet is applied about the base of a finger. A tourniquet of narrow calibre should be avoided and, for ordinary purposes, occlusion of the arterial supply is contra-indicated.

(5) When a bloodless field is desired, a properly applied Esmarch bandage is more effective and safer.

# TRANSACTIONS

OF THE

## NEW YORK SURGICAL SOCIETY

STATED MEETING HELD MAY 13, 1931

### ABDOMINAL HODGKIN'S DISEASE WITH INTESTINAL OBSTRUCTION

DR ALFRED STILLMAN presented a woman, forty-three years of age, who had been suffering for five years with attacks of nausea, vomiting and distention, at first apparently from injudicious eating, but gradually increasing in frequency. Two years ago she had an operation for hæmorrhoids. Eight months before admission to Roosevelt Hospital she had been to St. Lukes. Here a Wassermann was 1 plus. She came to Roosevelt Hospital because for five days she had been unable to retain anything on her stomach. She has lost fifty pounds in weight in seven months.

*Physical Examination*—Showed peristaltic waves in lower abdomen. No masses could be felt nor the liver or spleen. Laboratory findings were: Hæmoglobin, 84, red blood-cells, 4,600,000, white blood-cells, 4,900 with 76 per cent polymorphonuclears and 24 per cent lymphocytes. Blood-pressure, 114/30. No free hydrochloric acid in gastric test meal. X-ray of chest was normal. X-ray of the intestines showed considerable dilatation of numerous coils of small bowel, suggesting an obstruction of the small bowel. Urine showed sugar twice and red blood-cells twice.

At operation, November 13, 1930, a quantity of clear straw-colored fluid was aspirated from the abdominal cavity and this cultured later a staphylococcus albus. In the small intestinal wall, some few feet from the ileo-cæcal valve, there were several small, whitish masses two to three centimetres in diameter and umbilicated. In the mesentery of these loops was a matted mass of glands very firm in consistency and discolored as by hæmorrhage. The small gut above was dilated and hypertrophied and that below was normal.

One gland was removed for diagnosis. An enteroenterostomy was done between a loop above and one below the obstruction. This operation gave considerable relief but now, six months afterwards, she is again suffering from obstruction. She was presented because the retroperitoneal type of Hodgkin's disease is rare, and obstruction also is not common. The pathologic report was Hodgkin's disease.

### CHOLECYSTENTEROSTOMY FOR OBSTRUCTIVE JAUNDICE

DOCTOR STILLMAN presented a woman, forty-one years of age, who had been suffering from jaundice for five and one-half weeks. She was unable to keep anything on her stomach. The vomitus consisted of gastric contents and no bile. The stools were clay-colored and the urine dark. She complained only of occasional throbbing pain in her right side near the costal margin. She had lost some weight. The liver was not tender, was smooth, and its edge felt three inches below costal margin. Phthalein dye failed to show the outline of the gall-bladder and did not identify gall-stones.

At operation, November 27, 1929, the common duct was found dilated but the gall-bladder contained no palpable stones. A probe passed into an

## CHOLECYSTENTEROSTOMY FOR OBSTRUCTIVE JAUNDICE

opening made in the common duct seemed to stop at the papilla of Vater. The duodenum was opened opposite the end of the probe, which was then lifted to bring the papilla better into view. The probe entered the duodenum but it was not certain that it did not make a new opening to do so. The cause of the obstruction was not determined so an anastomosis was made between the duodenum and gall-bladder, using the incised wound already made in the duodenum.

Post-operatively, she was given calcium chloride for oozing. On December 2, hæmorrhage from the wound was alarming. Some sutures were removed and a bleeder located and ligated. Up to December 9 clots were removed from wound at dressings. December 16 the common-duct tube was removed. On the forty-third day bile stopped draining and the stools became brown.

Since her discharge about every two weeks she has had pain in the gall-bladder region, chills and fever. Otherwise she feels well and her weight remains normal. The question in this case is whether a stone has been missed or is it a case of infection through the anastomosis?

DR HENRY W. CAVE remarked that patients often had chills, fever and pain in the right upper quadrant when a stone has been left behind or has re-formed, or there has been an infection by way of the anastomosis. A few years ago surgeons were divided as to which was the best procedure—cholecystoduodenostomy or cholecystgastrostomy. In that connection, he discussed a case in whom a choledochointerostomy was done with a Murphy button. The patient made a satisfactory convalescence and had an excellent late result. He was a man sixty-eight years of age who, in August, 1927, had pain in the right upper quadrant accompanied by elevation of temperature. He was admitted to the Roosevelt Hospital, after three days' observation the gall-bladder was removed. It contained a large stone. The wound was drained from the upper angle. He continued to drain and lost about seventy pounds in weight, apparently through the persistent biliary fistula. At the time of the operation the common bile-duct had been examined, but no stones found. One hundred nine days after the choledochointerostomy he re-entered the hospital with clay-colored stools and a persistent biliary fistula. He was again operated upon and an attempt made to shunt this persistent fistula into the stomach. It was then thought there was an obstruction in the lower part of the common bile-duct. The common bile-duct proximal to this obstruction was markedly dilated. Adhesions were quite dense at the lower end of the common bile-duct, so that it was impossible to tell definitely whether a stone was present in the papilla of Vater. A Murphy button was first placed in the common bile-duct and anastomosed to the duodenum. This button was passed on the ninth day post-operative. The wound healed primarily. He was discharged after three weeks. He made a very uneventful recovery. Three months later he had gained fifty-eight pounds in weight. He has remained well since. The use of the Murphy button was advantageous particularly in this case, as it was a much quicker procedure than doing a suture operation. Some time had been wasted in trying to dissect out the original biliary fistulous tract and in a patient his age he was

not in too good a condition. As far as Doctor Cave knew, this was the only instance where a Murphy button had been used to do a choledochoduodenostomy.

DR. FREDERIC W. BANCROFT said that in doing a cholecystgastrostomy the use of the Murphy button provides a most satisfactory means of doing anastomosis in those cases where it is advantageous in the first forty-eight hours to have a discharge of bile. In bleeding cases, also, it may prevent bleeding around the sutures.

DR. WINFIELD SCOTT SCHLEY referred to a case he had ten years ago at St. Luke's Hospital of a woman with marked obstructive jaundice in which exploration showed a small, hard pancreas. The duodenum was near and an anastomosis was made between the gall-bladder and the duodenum. The anastomosis was quickly done using a small button with reinforced gut suture. She passed the button two years later after a sharp attack of pain in upper abdomen. Seven years later she was admitted to the emergency ward with an acute, gangrenous pancreatitis, from which she died. It is surprising that such a small, hard, contracted pancreas could (actively) function for such a length of time, and interesting that she should subsequently develop an acute pancreatitis causing death. She was apparently in excellent health on her visits to the follow-up clinic during these intervening years. Jaundice had entirely cleared following her operation.

DR. JOHN DOUGLAS called attention to the sedimentation time instead of the bleeding time in the blood in cases of obstructive jaundice. He said that a disadvantage in the use of the Murphy button was that it might fall into the gall-bladder and the patient subsequently have more pain because of this. This happened in one case of his and there was severe hæmorrhage and the patient died as a result of a second operation. While the Murphy button is expected to go into the stomach, it can fall back into the gall-bladder. Doctor Douglas had one case in which the patient had an abscess between the gall-bladder and the duodenum and came back with severe jaundice after cholecystectomy. It was subsequently necessary to do a lateral anastomosis by the suture method between the common duct and duodenum. If there is a large dilated duct there is no difficulty in making the anastomosis between the duodenum and the common duct. In regard to the question of dissecting out the sinus and inserting it into the stomach, one should never try to dissect the sinus beyond the liver margin, for if one tries to dissect it away from the edge of the liver one always gets into the sinus.

DOCTOR STILLMAN rejoined that, so far as he knew, the sedimentation test was not used at the Roosevelt Hospital. The clotting and bleeding time of jaundice cases are taken and when these are prolonged calcium chloride is given. In the case under discussion anastomosis to the stomach seemed simpler because of the deep position of the duodenum. It was done by the ordinary suture method. In those cases where severe bleeding is

## HEMANGIOMA OF THE ERECTOR SPINÆ MUSCLE

feared the Murphy button may be useful. As to whether there is more chance of infection extending to the liver when the anastomosis is made in the stomach or the duodenum, the speaker thought there was little difference and anastomosed that viscus which was easiest to bring up. At the first operation there was no stone seen or felt.

## HEMANGIOMA OF THE ERECTOR SPINÆ MUSCLE

DR EDWARD D. TRUESDELL presented a woman, thirty years of age, who had suffered from backache for five years or more. The pain had been particularly troublesome at night, tending to wear away during the day-time. Pain was situated in the middle and lower part of the back and was never associated with any other symptom. Upon inspection there was a slight prominence of the region just to the left of mid-line and below the twelfth rib. There was no discoloration of the skin, there was no tenderness and the swelling faded off into the surrounding tissues without a definite limit or circumscribing outline. An exploratory incision was made. Nothing was found in the subcutaneous fat. When the fascia covering the erector spinæ muscle was incised, the underlying muscle immediately bulged into the incision, as though under considerable tension. The muscle was a pale brown in color, obviously pathologic, but did not have the appearance of a vascular tumor. The diseased portion of the muscle removed was about the size of a horse-chestnut. There has been no further backache, the patient using her back vigorously in the course of her usual duties. While the gross appearance of the specimen removed did not suggest the nature of the trouble, the microscopic examination revealed the presence of a hemangioma.

The subject of primary hemangiomas of striated muscles has been thoroughly studied by Dr. John Staige Davis, who, in 1908, reported a series of six cases of his own and 147 cases derived from the literature up to that time. Again in 1930 Doctor Davis added eleven new personal cases, forty-eight cases appearing in the literature since his first article, the total being 212 in all. He believes these tumors for the most part to be congenital in origin, but may be aggravated by trauma, also that the tumors are rarely multiple or malignant. He has found that pain is their chief symptom, this being present in five out of six of his first cases and nine out of eleven of his second series. The pain is apparently due to pressure upon the nerves or to involvement of the nerves in the tumor itself. Pain also is more likely to occur in the long narrow muscles. There may be some functional impairment of the muscles involved, while the tumors are not usually tender, nor need there be discoloration of the overlying skin. While injections, actual cautery, electrolysis, X-ray and radium may be employed, he believes that excision is the best treatment. The majority of the cases have occurred in the muscles of the face, neck and extremities, those of the trunk being much less common.

DR SEWARD ERDMAN had not considered pain in connection with hemangioma a significant feature until he had a case last winter with pain in the inner aspect of the thigh. Operation was done for lymphangioma. There was no blood in the cut specimen. The patient, a girl of nineteen, had great pain and tenderness over the swelling, which was two inches in diameter. It elevated but did not involve the skin. The mass lay deep in subcutaneous fat. After removing it *en masse* the gross appearance of a cut section resem-

bled the cellular arrangement in a rubber sponge. There was no blood in it, but only clear fluid and Doctor Erdman assumed it to be angioma. The mother insists on the prenatal origin of this "birth-mark" and recounts while pregnant with this child, she, the mother, was hit on the inner side of the thigh with a pear which caused a black and blue spot and believed at the time this would mark her child, and, sure enough, when the child was born a similarly situated mark was found.

#### ANATOMIC TUBERCLE OF THE THUMB

DR GUILFORD S DUDLEY presented a man, twenty-eight years of age, a pathologist. He has always been quite well and gives no past history of infection by or susceptibility to tuberculosis. It has been his custom to perform autopsies with bare hands.

On September 30, 1930, he inflicted an incised wound about one quarter of an inch in length upon the skin of the dorsal aspect of his left thumb at the level of the metacarpo-phalangeal articulation. This accident occurred while sectioning a lung extensively diseased by caseous tuberculosis. The wound bled freely, was washed at once with running water, later was bathed with alcohol, and the incident dismissed from his mind. Primary union took place, but by October 5, 1930, a slightly raised erythematous area about three-eighths of an inch in diameter had appeared at the site of the injury. By October 10, 1930, this papular lesion seemed fully formed and showed a very small, superficially ulcerated zone at its central point. An occasional droplet of serous fluid appeared from this ulcer but at no time was there any evidence of active secondary infection. There was no pain, no adenitis, and no systemic symptom. Early in November, 1930, the lesion was treated by two therapeutic exposures to the X-ray. Following the second treatment the area of redness increased slightly in size but, in a few days, returned to its original condition.

On November 25, 1930, the lesion was excised under the pre-operative diagnosis of anatomic tubercle. This was performed under novocaine infiltration anaesthesia and, at the time, it was thought that the excision had been sufficiently wide to assure a complete cure. The skin edges were approximated under moderate tension and primary union took place throughout except at the distal extremity of the scar. At this point there developed an indurated papule about one-eighth of an inch in diameter, and, as in the instance of the first lesion, superficially ulcerated at its central point. After more than two months' unsuccessful treatment with the quartz mercury lamp, the second attempt at operative cure was undertaken. On March 1, 1931, under nitrous-oxide anaesthesia, the recurrent tubercle was excised widely and the defect covered with a full-thickness skin graft taken from the upper arm. This procedure was successful and the region involved is now healed completely.

Histologic examination of the first tubercle showed all the characteristics of an epithelioid tubercle without caseation. In addition, tubercle bacilli were found in a specially stained section. The second specimen also showed typical Langhans giant cells in an epithelioid tubercle without caseation. Tubercle bacilli were not found in this section.

DOCTOR DUDLEY also presented a second patient, a man, who is serving an internship in a hospital. It has been and still is his custom to perform autopsies with bare hands. His past and family history are completely negative for tuberculosis. In September, 1930, solely as a matter of interest, he

had a Mantoux test for tuberculosis performed. This was negative (1-10 dilution).

Early in January, 1931, he inflicted an incised wound of slight extent upon the skin of the dorsal aspect of his left thumb at the level of the metacarpophalangeal articulation. This accident occurred while the hand was submerged in tuberculous pus within the thorax in an effort to remove the larynx. The wound bled freely, was washed at once with running water, and tincture of iodine applied. On the following day the wound was re-opened purposely, again allowed to bleed freely, and tincture of iodine repeated. Primary union took place, but within a week, a slightly raised erythematous area almost one-half inch in diameter had appeared at the site of the injury. The lesion was not painful unless traumatized, and there were not systemic symptoms. Three weeks after its appearance the papule was treated by one therapeutic exposure to the X-ray. Two days later two tender, palpably enlarged lymph-nodes were present in the left axilla and the papule superficially ulcerated at its central point. A second X-ray treatment, given one week following the first, seemed again to be followed by increased activity within the local lesion with further enlargement of the axillary nodes. There were no additional constitutional symptoms and X-ray of the chest showed no active or healed tuberculosis. After ten days' rest in the country the axillary nodes subsided and the patient returned to the city for excision of the tubercle.

This procedure was carried out under general anaesthesia by Dr. Carl Burdick. A wide area of skin was removed and the defect covered with a full-thickness skin graft taken from the thigh. This graft is now eight weeks old and is attached firmly. There remains still a small crust on its ulnar side which is to be allowed to detach itself spontaneously.

Histologic examination showed typical Langhans giant cells in an epithelioid tubercle without caseation. Tubercle bacilli were not demonstrated.

These two cases were presented because of the comparative rarity of this manifestation of tuberculosis. It is a disease confined almost exclusively to pathologists, although butchers may develop a bovine type of tubercle. From the point of view of the pathologist, it is not so extremely uncommon. At Bellevue Hospital, where approximately 2,500 autopsies are performed annually (the second largest autopsy service in the world), the Director of Laboratories, Dr. Douglas Symmers, estimates that about twenty-five anatomic tubercles have occurred during the past fifteen years. In this period of time almost 250 internes, resident pathologists, *etc.*, performed autopsies. Thus, as considered by occupation, the infection takes place in somewhat less than one in every ten individuals. The experience gained from these two cases would seem to indicate that the most satisfactory type of treatment is immediate wide excision, with skin grafting to cover the defect.

Doctor Truesdell said that some twenty-five years ago tuberculous infections of wounds of the feet were occasionally seen in children at St. Mary's Hospital for Children. At this time it is probable that many more children ran barefooted than at present, and also that the bacillus of tuberculosis was more generally disseminated in the dirt of the street than now. The usual history was that there had first been some small cut or laceration of the sole of the foot, which had healed as usual but had soon reopened and continued to discharge. Upon incision of this area a localized tuberculous process was found to exist. It was not infrequent that following such a condition in the foot the femoral lymph-nodes became involved in a tuberculous infection.



## CHRONIC OSTEOMYELITIS OF THE TIBIA

DOCTOR DUDLEY presented a woman, twenty-eight years of age, who was admitted to the Second Surgical Division of Bellevue Hospital, April 30, 1931, complaining of pain and swelling of the right leg. She stated that an enlargement in the region of the right ankle, which seemed to vary in size from time to time, was first noticed about eighteen months before but that not until twelve months later did she suffer from any pain. This pain was situated in the upper third of the leg and accompanying it there appeared a swelling in this region. Since then this swelling has extended progressively to involve practically the entire leg, and motion at the knee-joint has become restricted. Although pain was one of her complaints upon admission, this symptom has not been a prominent feature and is present only upon walking. She gave no history of chills or fever and to her knowledge has had no previous illness which would throw any light upon her present condition. She had been told that a blood test taken elsewhere about six months ago was reported to be negative. She has had but one pregnancy and this terminated spontaneously at two months. She has gained twenty pounds in weight during the past year. There is a diffuse enlargement of the entire right lower leg from the knee to the ankle, particularly marked in the upper half. Many superficial distended venules are seen within the skin on the anterior aspect of the lower half and slight oedema in the region of the ankle. Tenderness to pressure was only of moderate degree, but was more pronounced in the upper half of the leg. Profuse perspiration was present on the entire leg but not on other surfaces of the body. Upon palpation the swelling was of bony, hard consistency and apparently caused by involvement of the tibia. Extension of the leg at the knee-joint was restricted slightly. A few firm lymphatic glands were palpable in both inguinal regions. General physical examination showed a somewhat highly arched palate and slightly unequal pupils which reacted promptly to light and accommodation but no other stigmata of congenital lues. Temperature, pulse and respiration were normal.

The laboratory reported 4,200,000 red blood-cells with 50 per cent of hæmoglobin and marked central achromia of the cells. White blood-cells were 10,000 with 74 per cent of polymorphonuclears. Urinalysis was normal (no Bence-Jones protein). The Wassermann reaction was four plus.

The X-ray department reported chronic osteomyelitis of the entire shaft of the tibia with bony sclerosis and periosteal thickening extending to and involving the lower end of the corresponding femur. Radiographic examinations of the remaining long bones, the skull, and the thorax were negative. Since then discussion has centred about the probability of luetic osteo-periostitis and the decision to test the result of anti-luetic treatment has been reached.

She is presented to the society because of the interest attached to the diagnosis.

DR LEON T LEWALD said that his impression was that this condition is not osteomyelitis, as he believed it lacked the classical signs, as far as the X-ray was concerned. Involvement of the lower end of the femur is not distinct in the X-ray film, but provided there is such involvement it might well be due to a secondary metastatic lesion. He recalled a similar case in a young woman in whom there was complete swelling of the leg from the knee down. It looked like osteomyelitis but lacked the characteristics of this

## BACTERIAL SYNERGISM IN DISEASED PROCESSES

disease in regard to pain and suppuration. Biopsy was performed by Dr. William B. Coley and there was some question as to the exact histologic picture. The pathologist said it was a secondary manifestation of a hypernephroma. There were some changes which were similar to those in this case which might indicate malignancy. In Baltimore, they have worked out an elaborate chart by which they try to make a positive diagnosis of a given bone tumor. This case was submitted to Doctor Bloodgood's clinic and they reported that it might be a metastatic lesion, but that in their experience secondary growths did not occur below the knee-joint or below the elbow, so the case was still left in doubt. Doctor LeWald said that in his experience secondary metastatic lesions have been seen below the knee and beyond the elbow.

DR. ALLEN O. WHIPPLE asked why lues had been so generally ruled out in this case considering the positive Wassermann, early termination of pregnancy, unequal pupils, lack of leucocytosis and sabie-shaped appearance of the bone.

## BACTERIAL SYNERGISM IN DISEASED PROCESSES

DR. FRANK L. MELENEY read a paper with the above title for which see page 961.

DR. ALLEN O. WHIPPLE expressed his appreciation of this work done by Doctor Meleney. Aside from the original character of the work itself the value of an investigation of this sort in the development of a bacteriologic research in the general surgical service is great. This is but one example of the help and benefit Doctor Meleney and Doctor Harvey and other workers in that laboratory have been to the Surgical Service of the Presbyterian Hospital. Aside from this individual piece of research, the beneficial effect of having men on the service who are familiar with both the bacteriologic and surgical applications becomes definite, as well as constant, in the study of wound healing and the efforts to improve primary healing in clean wounds, and in the technic of the operating room. Doctor Whipple particularly called attention to the work done in Doctor Meleney's laboratory in regard to the sterilization of catgut and he trusted the Bureau of Standards would in future demand standardization in the sterilization of catgut, which has been very deficient in some of the catgut manufactured.

## BRIEF COMMUNICATIONS

### HEAD OF FIBULA IN HIGH AMPUTATIONS OF LEG

THE remarks of Doctor Marks, in the ANNALS OF SURGERY, May, 1931, vol xciii, p 1118, regarding the disposition of the head of the fibula in high amputations of the leg suggest the following practical points

The removal of the fibular head makes a smooth and conical shaped stump, prevents the secondary pain and disturbance caused by the bone end. It also permits the operator to resect the external popliteal nerve (and inject it with alcohol) at a higher level, thus obviating some of the chances of amputation neuroma and its sequences

Objections to the removal of the head of the fibula are

It involves more cutting and a more prolonged operation

In removing the head the operator may (a) cut into the knee-joint unknowingly, or (b) connect the amputation wound into the knee-joint by opening the bursa about the head of the bone and the interosseous membrane. This bursa may connect by a small passage or be a real accessory pocket of the knee-joint itself

Should the amputation be elective and aseptic no untoward result may follow. If the amputation is one of urgency, as many *high* amputations are, or if they concern infected tissues, or tissues devitalized which may slough or become infected, the fibula head had best be left *in situ* to guard against infection spreading into the knee-joint. I have seen several such unhappy infections and their sequences after removal of the head of the fibula in septic and potentially septic legs in civil practice and also in those encountered a few years ago in France and Belgium

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### THE PRODUCTION OF PEPTIC ULCER AFTER SECTION OF THE GASTRIC NERVE

THIS study was made with the purpose of determining if sectioning the nerves to the stomach in any way modified the development of peptic ulcer produced by a standardized method. It seems reasonable to assume, from what has been written on the function of the vagus nerves and splanchnic nerves in relation to the physiological processes of the stomach, that these nerves might be significant in the development of ulcer, particularly since Durante<sup>3</sup> was able to produce superficial ulcers in rabbits by merely dividing these nerves. Carlson<sup>2</sup> stated that combined section of the vagus nerves and splanchnic nerves results practically in permanent hypotonus of the stomach except under conditions of prolonged starvation. Alvarez<sup>1</sup> has

stated that the vagus nerves carry the stimuli which give rise to psychic secretion of gastric juice and that the splanchnic nerves have an inhibiting action serving to quiet the digestive tract, but that the action of these nerves on the stomach and bowel is generally transient. McCrea and McSwiney<sup>5</sup> have shown that the pylorus derives a portion of its nerve supply from a large branch of the vagus nerve which passes from the region of the cardia to the liver. C. H. Mayo<sup>7</sup> has expressed the belief that both duodenal and gastric ulcers are in all probability accompanied by pylorospasm, he has, therefore, divided this branch of the vagus nerve in cases in which it was evident that the trouble in the stomach was reflex. Hartzell<sup>4</sup> has shown that section of the vagus nerves definitely decreases the acidity of the gastric secretion.

Mann and Williamson<sup>6</sup> described a method for experimental production of peptic ulcer. Briefly, the method consists in severing the duodenum from the pylorus and turning in the end of the duodenum. The first part of the jejunum is sectioned and the distal of the two ends thus made is anastomosed end-to-end to the pylorus. The proximal of the two ends made by sectioning the jejunum is anastomosed side-to-side to the terminal portion of the ileum. By this arrangement all of the duodenal secretions, mixed with the bile and pancreatic juice, are drained far enough from the stomach to prevent regurgitation of the duodenal content into the pyloric region of the stomach. The jejunum, which has been placed in a position similar to that of the normal position of the duodenum, receives all of the gastric secretions, without any possibility of their being mixed with the secretions which are poured into the duodenum. Under such circumstances, the usual site for the formation of ulcer is on the dorsal wall of the jejunum laterally to the right of the long axis of the bowel, 1 centimetre or more distal to the anastomosis.

Three series of experiments were performed in each of which three normal, healthy dogs were selected. All operations were performed under ether anaesthesia and with strictly aseptic technic. Intestinal clamps were not used. Following operation all the dogs received the usual mixed food and in addition milk and syrup.

In the first series of experiments, which was the control for the investigation, duodenal drainage was instituted surgically unmodified by any other procedure. In the second series, preliminary section of the splanchnic nerves was performed. This was done by completely stripping the adventitia from all the vessels in the coeliac axis. After the animals had recovered and had regained any weight which initially they might have lost, duodenal drainage was instituted surgically. In the third series, the vagus nerves were sectioned in a preliminary operation. In order to be sure that the nerves were severed they were cut in the thorax. They were picked up on each side of the oesophagus, just above the diaphragm, and about one centimetre was excised from each. After the animal had recovered from this operation, duodenal drainage was instituted surgically.

## BRIEF COMMUNICATIONS

Briefly, the results were the development of a typical peptic ulcer in each experiment, except in one in which the vagus nerves had been sectioned

Section of nerves to the stomach did not prevent the development of ulcer in that portion of the intestines which received the gastric content after measures had been taken to drain the duodenal secretion away from that region

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### STRANGULATED EPIPLOIC APPENDIX SIMULATING APPENDICITIS

TORSION of the epiploic appendix giving rise to acute abdominal symptoms may be easily confused with acute appendicitis In more than 50 per cent of the cases reviewed by Johansson, the diagnosis of acute appendicitis was made, in no case was the correct diagnosis made before operation The case reported here is of interest because of the rarity of the condition, and because it is the result of true torsion, the meso-appendix being involved secondarily

A woman, aged thirty-three years, was admitted to hospital June 6, 1931, because of pain in the right lower quadrant of the abdomen The pain had not been severe as a rule, and was relieved by rest in bed for a few hours She had never had any acute attacks of abdominal pain associated with nausea or vomiting She had been constipated and occasionally some pain in the right side was associated with defecation A diagnosis of chronic recurrent appendicitis was made

June 9, 1931, the abdomen was explored The uterus and adnexa were normal The gall-bladder felt normal and did not contain stones The appendix, however, was long and was attached to a tumor about two centimetres in diameter low in the pelvis The tumor was the result of a twisted epiploic appendix of the sigmoid, circulation to it was completely cut off The tumor was attached to the sigmoid by a thin pedicle about one and one-quarter centimetres long and was removed without difficulty The appendix also was removed

## STRANGULATED EPIPLOIC APPENDICITIS

The appendix was 6 by 0.6 centimetres. The serosa was slightly injected, otherwise it did not show evidence of infection. The tumor attached to the meso-appendix measured 2 by 1.8 centimetres. It was lobulated and multilocular and contained clear fluid. The diagnosis of a strangulated epiploic appendage was verified in the laboratories of The Mayo Clinic. Recovery was uneventful and the patient left the hospital on the twelfth post-operative day.

Lesions arising in the epiploic appendix are generally considered due to some interference with the blood supply. Strangulation may take place slowly or suddenly and is usually associated with the formation of cysts. Klingenstein has noted that these cysts may become as large as about 5 centimetres in diameter, they may not become infected, but there is frequently considerable inflammatory reaction, which results in adhesions to neighboring organs and acute abdominal symptoms may arise.



FIG. 1.—Strangulated epiploic appendage attached to the meso appendix.

Klingenstein, in 1924, reviewed from the literature fifty-three cases of which twenty were due to torsion and retained attachment to the colon, twelve were loose bodies within the peritoneal cavity and twenty were associated with hernia. The first two groups are of especial significance.

The term epiploic appendix originated from Meckel. The appendages which consist of finger-like pouches of peritoneum containing varying amounts of fat are found along the whole of the large intestine except the rectum, they are more numerous in the transverse and pelvic colon. The various courts of the large intestine do not enter into their formation. Their number varies but Johansson quoted Robinson as having noted about 100.

In the cases in which hernia is a complication the interference with circulation is easily understood. However, it is believed that in many of these cases torsion occurs within the hernial sac. The epiploic appendix may become distended with fluid. The cystic masses may become infected and give rise to symptoms simulating intestinal obstruction. Operation is usually performed for strangulated hernia and the true condition is discovered.

## BRIEF COMMUNICATIONS

In the cases generally referred to under the term intra-abdominal torsion, it is not so easy to understand the interference with circulation. Payr has suggested that disproportion between the artery and vein is the cause. Occasionally the epiploic appendix has been found twisted one or more times on its pedicle. Necrosis of its pedicle may occur and the appendix drops off, and remains a foreign body in the peritoneal cavity. There are twelve of these cases on record. These cases, however, are not of especial clinical interest, the condition is usually found during laparotomy for some other condition.

Two other types of torsion may occur which are of more clinical significance. Gradual interference with the blood supply may result in a chronic inflammatory mass and this may become attached to the omentum or as in the case reported the appendix forms a potential means of mechanical intestinal obstruction.

In still another type the epiploic appendix becomes distended with fluid but retains its attachment to the colon. Cystic masses about 5 centimetres in diameter have been reported as retaining their attachment to the colon by long pedicles. These may or may not become inflamed. Sometimes most acute abdominal symptoms may arise necessitating immediate operation.

The diagnosis is extremely difficult. In none of the twenty cases of torsion necessitating immediate operation, reviewed by Johansson was the diagnosis made pre-operatively. Appendicitis is the most common diagnosis.

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